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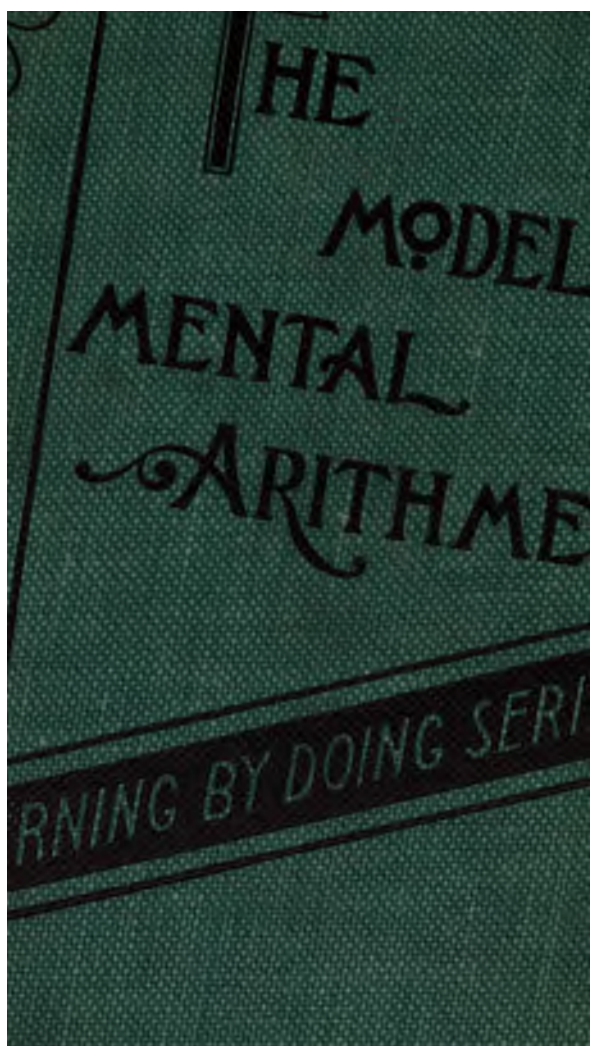
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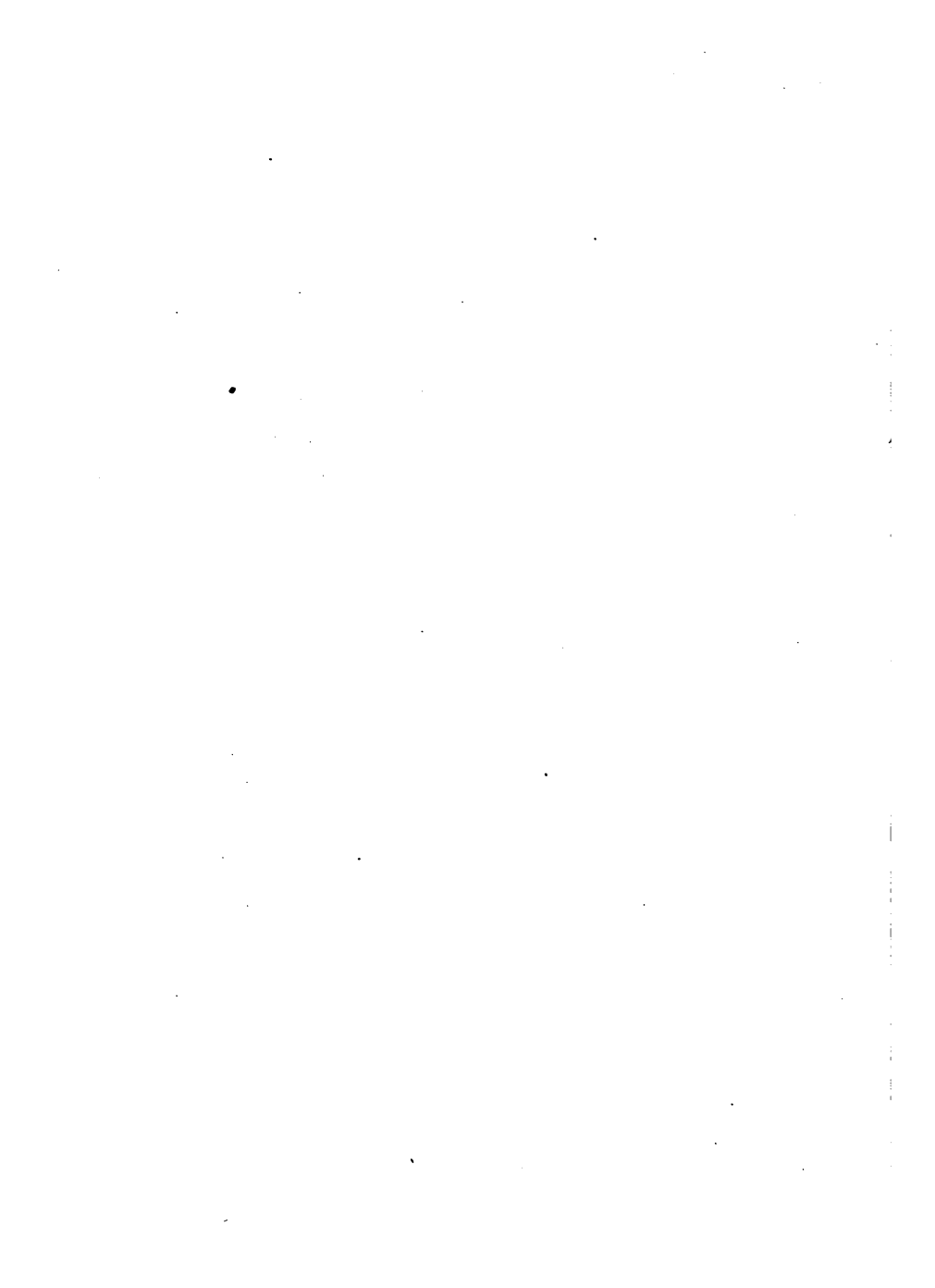
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THE MODEL

MENTAL ARITHMETIC

FOR

PUBLIC AND PRIVATE SCHOOLS

*Charles Bittskey*

BY C. F. R. BELLOWS,

For many years Professor of Mathematics in Michigan State Normal School.  
Author of a series of mathematical text-books.

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## PREFACE.

MENTAL ARITHMETIC as a means of mental training, especially of the logical powers of the student, has always occupied a high place in the estimation of teachers. In the regard, however, which has been bestowed upon it as an intellectual gymnastic, its value as a medium of acquisition of arithmetical knowledge, has been almost entirely overlooked.

It is from this latter point of view of the subject that the present book has been written.

The tendency of the times in the direction of trimming Arithmetic of all matters of doubtful or remote utility, urges a directness of approach and an economy of space in the treatment even of the essentials of the subject.

Accordingly, the scope of Mental Arithmetic as here exhibited stands for a union of the purposes, of Mental Arithmetic, as a means of mental discipline, and as a medium of acquisition of arithmetical knowledge generally agreed upon as indispensable.

While the familiar custom of presenting forms of analysis of solutions has not been discarded, it will be easily seen that the book has not been made entirely for the sake of exhibiting specimens of mathematical reasoning. The general abandonment of the formal use of "therefores" and "wherefores" and "hences" stiffly set up is sufficient evidence upon this point. On the other hand, a preponderance of questions of a practical nature, clearly evinces the spirit of the book as designed to promote the attainment of useful knowledge.



The book has been prepared with a view to uniting the requirements of a first book in Arithmetic, for use in grammar grades, and also for the purposes of Mental Arithmetic drill in high schools. Although the subject-matter for these different purposes is not separated in the book, nevertheless the two are easily distinguishable.

It is hoped that the contribution here made to the cause of arithmetical teaching in our schools may prove a valuable one.

C. F. R. B.

*Battle Creek, Mich.*

# MENTAL ARITHMETIC.

## LESSON I.

### ADDITION.

1. Henry has 2 books in one hand and 1 book in the other; how many books has he in both hands?

*Answer.*— *He has in both hands 2 books and 1 book, or 3 books.*

2. John has 2 marbles and Henry has 2; how many marbles have they together?

*Answer.*— *They have together 2 marbles and 2 marbles, or 4 marbles.*

3. Susan has 2 paper dolls and Mary has 3; how many paper dolls have they together?

*Answer.*— *They have together 2 paper dolls and 3 paper dolls, or 5 paper dolls.*

4. How many are 2 and 1? *Answer.*— *2 and 1 are 3.*  
How many are 2 and 2?  
How many are 3 and 2?

5. Two boys each found 3 marbles; how many marbles did they both find?

6. Willie picked 3 roses and his sister picked 4; how many roses did they together pick?

7. Sarah has 5 classes in the forenoon and 4 classes in the afternoon; how many classes has she during the day?

8. There are 3 boys in a class and 5 girls; how many pupils are there in the class?

*Answer.*— *There are 3 pupils and 5 pupils, or 8 pupils.*

9. A boy earned 5 cents on Monday and 5 cents on Tuesday; how many cents did he earn in the two days?

10. How many are 3 and 3? *Answer.*— *3 and 3 are 6.*

How many are 3 and 4?

How many are 5 and 4?

How many are 4 and 2?

How many are 5 and 5?

11. William had 4 cents in his hand and 4 cents in his pocket; how many cents had he?

12. There are 4 boys in one class and 6 boys in another class; how many boys are there in the two classes?

13. Emma put 3 roses in one vase and 6 roses in another vase; how many roses did she put in both vases?

14. There are 2 girls in a certain family and 5 boys; how many children are there in the family?

15. How many days are 7 days and 3 days?

16. Jennie had 6 little girls and 2 little boys at her party; how many children were at Jennie's party?

17. Henry had 8 cents and his father gave him 2 cents more; how many cents did Henry have then?

18. How many are,—

2 and 3?	1 and 5?	6 and 2?	2 and 7?
1 and 2?	3 and 1?	4 and 4?	6 and 3?
4 and 1?	5 and 2?	6 and 1?	5 and 5?
2 and 2?	4 and 3?	3 and 5?	3 and 7?
7 and 1?	5 and 4?	4 and 6?	8 and 1?
3 and 3?	8 and 2?	2 and 4?	1 and 9?

## LESSON II.

19. John had 9 pigeons and bought 2 more; how many pigeons had he then?

20. Charles found two hens' nests. In one there were 8 eggs and in the other 3 eggs; how many eggs were there in both nests?

21. A man paid 9 dollars for a coat and 3 dollars for a vest; how many dollars did he pay for both garments?

22. Mary picked 7 quarts of cherries from one tree and 4 quarts from another; how many quarts did she pick from both trees?

23. A farmer sold 8 chickens and 4 ducks; how many fowls did he sell?

24. There are 9 girls and 4 boys in a class; how many pupils are there in the class?

25. Henry earned 5 cents in the morning before school, and 6 cents in the evening; how many are 5 cents and 6 cents?

26. There are 6 pupils in each of two classes; how many pupils are there in both classes?

27. How many cents are 5 cents and 7 cents?

28. Willie had 7 cents and his mother gave him cents more; how many cents had he then?

29. There were 8 birds on one tree and 5 birds on another; how many birds were there on both trees?

30. A farmer sold 4 sheep to one man and 9 sheep to another man; how many sheep did he sell to the two men?

31. If I pay 9 dollars for a coat and 5 dollars for a pair of pants, how many dollars do I pay for both?

32. How many boys are 8 boys and 6 boys?

33. How far will a boy have to walk, in walking to a town 7 miles distant and walking back?

34. How many minutes in 9 minutes and 6 minutes?

35. Samuel is now 7 years old; how old will he be 8 years from now?

36. William is 9 years old and his sister Mary is 7 years older; how old is Mary?

37. There are 8 panes of glass in each of two windows; how many panes of glass in both windows?

38. How many are 8 books and 9 books?

39. There are 9 apples in each of two baskets; how many apples are there in both baskets?

40. How many are,—

2 and 9?      8 and 5?      9 and 5?      8 and 6?

8 and 3?      6 and 6?      5 and 7?      9 and 9?

7 and 4?      9 and 4?      8 and 9?      6 and 9?

5 and 6?      7 and 6?      7 and 7?      8 and 7?

9 and 3?      4 and 8?      9 and 7?      8 and 8?

41. James is 10 years old. What will be his age when he is 1 year older? When he is 2 years older?

42. How many are,—

10 and 3?    10 and 4?    10 and 9?    10 and 8?

10 and 5?    10 and 6?    10 and 7?    10 and 10?

4 and 10?    6 and 10?    7 and 10?    2 and 10?

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### LESSON III.

43. Bought a suit of clothes for 11 dollars and a hat for 1 dollar; what did I pay for both?

44. George is 11 years old and his sister is 2 years older; how old is she?

45. Ruth paid 11 cents for paper and 3 cents for pens; what did she pay for both?

46. How many are 11 and 4? 11 and 6? 11 and 5? 11 and 8? 11 and 7? 11 and 9?

47. There are 12 hens in a flock and one rooster; how many fowls in the flock?

48. A farmer sold 12 bushels of corn and 2 bushels of buckwheat; how many bushels of grain did he sell?

49. There are 12 eggs in one nest and 3 eggs in another; how many eggs in both nests?

50. How many are 12 and 4? 4 and 12? 6 and 12? 12 and 8? 12 and 5? 7 and 12? 12 and 9?

51. How many are 13 boys and 1 boy? 13 girls and 2 girls? 13 books and 3 books? 13 pencils and 4 pencils?

13 and 6? 13 and 5? 13 and 7? 13 and 9?  
6 and 13? 13 and 8? 5 and 13? 9 and 13?

52. How many are 14 years and 1 year? 14 months and 2 months? 14 weeks and 3 weeks? 4 days and 14 days?

4 and 6? 4 and 5? 4 and 7? 4 and 9?  
14 and 6? 14 and 5? 14 and 7? 14 and 9?  
6 and 14? 5 and 14? 14 and 8? 9 and 14?

53. How many hoops are 15 hoops and 1 hoop? 15 hoops and 2 hoops? 3 hoops and 15 hoops?

54. How many are,—

5 and 4? 5 and 8? 15 and 6? 9 and 15?  
15 and 4? 15 and 8? 6 and 15? 9 and 5?  
5 and 7? 8 and 15? 5 and 9? 15 and 5?  
15 and 7? 5 and 16? 15 and 9? 5 and 15?

55. How many are 16 dogs and 1 dog? 16 sleds and 2 sleds? 16 whips and 3 whips? 16 boys and 4 boys?

6 and 5?    6 and 7?    16 and 9?    16 and 6?  
 16 and 5?    16 and 7?    9 and 16?    6 and 8?  
 5 and 16?    6 and 9?    6 and 6?    8 and 16?

56. How many are 17 cradles and 1 cradle? 17 dolls and 3 dolls? 17 dresses and 2 dresses? 17 girls and 4 girls?

7 and 8?    6 and 7?    7 and 7?    7 and 9?  
 17 and 8?    6 and 17?    17 and 7?    17 and 9?  
 8 and 17?    17 and 5?    7 and 17?    9 and 17?

57. How many are 18 horses and 1 horse? 18 men and 2 men? 18 harnesses and 3 harnesses?

8 and 5?    18 and 7?    18 and 8?    8 and 9?  
 18 and 5?    18 and 4?    8 and 18?    18 and 9?  
 8 and 7?    8 and 8?    18 and 6?    9 and 18?

58. How many are 19 pears and 1 pear? 2 apples and 19 apples? 19 peaches and 3 peaches?

9 and 6?    19 and 9?    9 and 5?    9 and 9?  
 19 and 6?    4 and 9?    19 and 5?    19 and 9?  
 9 and 9?    4 and 19?    19 and 8?    7 and 19?

**Addition** is the process of uniting two or more numbers in a single number. The single number obtained by addition is called the *sum*.

The symbol  $+$  is the sign of addition.

The symbol  $=$  is the sign of equality. Thus  $3 + 2 = 5$ , which may be read "3 plus 2 equals 5," or "3 and 2 are 5."

**Principles:** —

1. Only numbers of the same unit can be added.
2. The **sum** is the same in whatever order the numbers are added.

**LESSON IV.****I. TABLE FOR DRILL.**

$4+9=?$	$9+9=?$	$2+7=?$	$8+4=?$
$2+8=?$	$3+7=?$	$4+7=?$	$5+5=?$
$1+6=?$	$2+2=?$	$1+9=?$	$6+7=?$
$9+7=?$	$3+5=?$	$3+8=?$	$5+8=?$
$8+9=?$	$6+9=?$	$3+3=?$	$1+3=?$
$5+6=?$	$7+8=?$	$5+9=?$	$2+5=?$
$7+5=?$	$2+9=?$	$2+4=?$	$6+8=?$
$6+6=?$	$9+1=?$	$7+7=?$	$4+5=?$
$8+8=?$	$1+4=?$	$1+2=?$	$3+6=?$
$9+1=?$	$2+6=?$	$4+4=?$	$7+1=?$
$2+3=?$	$3+9=?$	$6+4=?$	$4+7=?$

**LESSON V.****II. TABLE FOR DRILL.**

$25+9=?$	$41+3=?$	$64+7=?$	$74+6=?$
$93+2=?$	$13+2=?$	$28+3=?$	$16+7=?$
$34+9=?$	$29+7=?$	$52+9=?$	$91+2=?$
$99+1=?$	$36+3=?$	$35+7=?$	$32+8=?$
$45+2=?$	$88+4=?$	$96+3=?$	$24+5=?$
$26+8=?$	$12+9=?$	$67+9=?$	$62+8=?$
$18+5=?$	$43+7=?$	$82+2=?$	$17+5=?$
$24+5=?$	$63+8=?$	$37+8=?$	$46+4=?$
$86+7=?$	$72+4=?$	$76+4=?$	$89+6=?$
$73+4=?$	$27+5=?$	$92+2=?$	$97+2=?$
$18+3=?$	$33+9=?$	$44+6=?$	$39+6=?$
$52+9=?$	$87+7=?$	$23+8=?$	$78+4=?$
$94+6=?$	$55+6=?$	$79+6=?$	$49+8=?$
$84+5=?$	$14+2=?$	$47+9=?$	$77+7=?$
$59+8=?$	$85+5=?$	$68+3=?$	$38+9=?$



## LESSON VI.

1. Henry has 5 cents, John has 8 cents, and James has 6 cents; how many cents have they together?

*Answer.*— *They have together the sum of 5 cents, 8 cents, and 6 cents, or 19 cents.*

2. Sarah picked 7 roses, Mary picked 5 roses, and Julia picked 3 roses; how many roses did they all pick?

3. A man paid 6 dollars for apples, 8 dollars for potatoes, and 3 dollars for turnips; how many dollars did he pay for all?

4. There were 12 acres in one lot, 10 acres in another lot, and 8 acres in another; how many acres were there in the three lots?

5. John paid 10 dollars for a coat, 5 dollars for a pair of pants, and 3 dollars for a vest; how many dollars did he pay for the suit?

6. A farmer has 4 horses, 8 cows, and 6 pigs; how many animals has he?

7. Mary paid 7 cents for paper, 6 cents for pens, and 5 cents for ink; how many cents did she pay for her purchase?

8. There are 13 pupils in a grammar class, 8 in an arithmetic class, and 4 in a Latin class; how many pupils are there in the three classes?

9. Samuel paid 15 cents for a book, 6 cents for paper, and 7 cents for pens and ink; how many cents did he pay in all?

10. There were three girls whose ages were 9 years, 11 years, and 10 years; what was the sum of their ages?

11. How many days are 7 days, 9 days, and 6 days?

*Answer.*— 7 days, 9 days, and 6 days are 22 days.

12. How many hours are 15 hours, 7 hours, and 5 hours?

13. How many are,—

6, 7, and 9?	5, 9, and 4?	9, 13, and 8?
12, 6, and 5?	10, 8, and 7?	15, 4, and 5?
8, 12, and 10?	14, 6, and 4?	13, 9, and 7?

14. What is the sum —

Of 4, 3, 5, and 8?	Of 6, 7, 4, and 3?
Of 8, 5, 7, and 6?	Of 9, 6, 7, and 5?
Of 10, 4, 6, and 9?	Of 12, 5, 8, and 4?

15.  $7+5+6+8=?$      $8+6+6+5=?$      $11+7+4+3=?$

16. Count by 2's from 2 to 50; thus 2, 4, 6, etc.

17. Count by 2's from 3 to 49.

18. Count by 3's from 1 to 52; from 2 to 50; from 3 to 51.

19. Count by 4's from 1 to 49; from 2 to 50; from 3 to 51; from 4 to 52.

20. Count by 5's from 1 to 51; from 2 to 52; from 3 to 53; from 4 to 54; from 5 to 50.

21. How many are,—

$8+5+7?$	$9+4+8?$	$6+5+9?$	$7+6+6?$
$9+7+4?$	$5+3+9?$	$8+8+7?$	$5+9+8?$
$10+6+5?$	$11+4+7?$	$12+5+6?$	$13+4+7?$

22. How many are,—

$14+6+8?$	$15+7+9?$	$16+8+8?$	$17+9+3?$
$18+4+7?$	$19+8+5?$	$20+7+9?$	$21+5+6?$
$22+5+5?$	$23+7+7?$	$24+8+8?$	$25+7+8?$
$33+6+4?$	$37+6+5?$	$38+4+3?$	$35+9+6?$

[illegible]

## LESSON VII.

## SUBTRACTION.

1. John had 3 apples and ate 1 of them; how many apples had he left?

*Answer.*— *He had left 3 apples less 1 apple, or 2 apples.*

2. William had 5 cents and spent 2 cents for a pencil; how many cents had he remaining?

*Answer.*— *He had remaining 5 cents less 2 cents, or 3 cents.*

3. There were 7 roses on a bush and Jennie picked 3 of them; how many roses were left on the bush?

4. How many are,—

7 less 4?      *Answer.*— *7 less 4 are 3.*

8 less 3?      6 less 2?      8 less 4?      10 less 2?

9 less 2?      7 less 5?      9 less 6?      10 less 5?

5. What number of books added to 7 books make 10 books?

*Answer.*— *3 books added to 7 books make 10 books.*

6. Mary is 6 years old; in how many years will she be 10 years old?

7. Henry is 12 years old and his sister is 7 years old; how many years older is Henry than his sister?

8. A man gave 11 dollars for a suit of clothes, and 6 dollars for wood; how many dollars more did he give for the clothes than for the wood?

9.  $6 + \text{what number} = 11?$        $5 + \text{what number} = 15?$

$7 + \text{what number} = 14?$        $3 + \text{what number} = 12?$

$9 + \text{what number} = 15?$        $4 + \text{what number} = 14?$

10. 11 less 6=what number?    12 less 3=what number?  
14 less 4=what number?    16 less 7=what number?  
15 less 7=what number?    18 less 9=what number?

11. Susan had 15 yards of ribbon, and her sister had 6 yards; how many yards more did Susan have than her sister?

12. A man engaged to work 18 days, and his son 9 days; how many days less was the son to work than his father?

13. A farmer had 14 acres of corn, and 5 acres of oats; how many acres more of corn had he than of oats?

14. In a class, there were 15 girls, and 8 boys; how many boys less were there than girls?

15. In a recitation, 17 questions were answered correctly, and 9 incorrectly; how many questions more were answered correctly than incorrectly?  $9 + \text{what number} = 17$ ?

16.  $5 + \text{what number} = 12$ ?    17 less what number  $= 9$ ?  
6 + what number  $= 15$ ?    16 less what number  $= 7$ ?  
7 + what number  $= 13$ ?    14 less what number  $= 8$ ?  
9 + what number  $= 14$ ?    15 less what number  $= 9$ ?

17.  $4 + 3 + \text{what number} = 12$ ? equals 15? equals 16?

18. 14 less  $5 + \text{what number} = 15$ ? equals 18? equals 16?

19. Lewis bought some paper for 6 cents and a bottle of ink for 5 cents, for which he handed the clerk 15 cents; how many cents should he receive back in change?

20. A farmer bought a plow for 8 dollars, and a cultivator for 5 dollars. He paid for them with two ten-dollar bills; how many dollars should he receive back?

21. A farmer has 5 pigs in one pen, and 8 pigs in another. He buys as many as to make his number 19 pigs; how many does he buy?

22. Jennie is 6 years old; in how many years, if she lives, will she be 13 years old?

**Subtraction** is the process of taking a part of a number away to find the part that is left. In a class of examples, **Subtraction** is the process of finding how many more, or less, one number is than another. In such examples, the result is called a *difference*.

The number of which a part is taken away is called the *minuend*.

The part of the minuend taken away is called the *subtrahend*.

The part of the minuend left, after taking away the subtrahend, is called the *remainder*.

The symbol — is the *sign* of subtraction. The sign of subtraction is read "*minus*," or "less."

In denoting subtraction by use of the sign minus, the minuend is written on the left of the sign and the subtrahend on the right. Thus,  $12-7$  denotes that 7 is to be subtracted from 12.

**Principles : —**

1. Only numbers having the same unit can be subtracted.
2. The minuend is the sum of the subtrahend and remainder.

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## LESSON VIII.

23. John had 25 cents, and spent 17 of them for a slate; how many cents had he remaining?

24. William is 19 years old, and Henry is 14; what is the difference of their ages?

25. A farmer has 24 sheep, and 15 hogs; how many sheep more has he than hogs?

26. Sarah picked 23 quarts of berries, and sold 16 quarts; how many quarts had she remaining?

27. Henry had 27 cents; he bought a book for 16 cents, and some apples for 3 cents; how many cents had he remaining?

28. A man bought a cow for 18 dollars, and sold her for 25 dollars; how many dollars did he gain?

29. Samuel has 26 cents, and George has 19 cents; how many cents more has Samuel than George?

30. A boy earned 29 cents in 3 days. The first day he earned 11 cents, the second day, 12 cents; how many cents did he earn the third day?

31. There are 35 boys and girls in a room. If 28 of them are girls, how many are boys?

32. A man had 37 dollars. He paid out of it 15 dollars for wood and 13 dollars for coal; how many dollars had he left?

33. A man received 34 dollars for a month's work, which was 22 dollars more than he paid for his board; how many dollars did his board cost?

34. Bought a wagon for 43 dollars, and sold it for 29 dollars; how many dollars did I lose?

35. David bought a book for 18 cents, a slate for 15 cents, and some paper for 5 cents. He gave the clerk 50 cents in payment; how many cents should he receive back?

36. A owes B 46 dollars; how many dollars will he owe him after paying 25 dollars?  $46 - 25 =$  how many?

37. A man had 45 acres of land; how many acres had he after selling A 13 acres and B 14 acres?  $45 - 13 - 14 =$  how many?

38. In an orchard of 48 trees, there were 16 Greenings, and the rest were Baldwins; how many were Baldwins?

39. There were 44 ladies and gentlemen in a company; if 26 were ladies, how many were gentlemen?

40. A farmer took a load of 50 bushels of corn and oats

to market; if there were 20 bushels of corn, how many bushels of oats were there?

41. Count the change for a half-dollar on purchases to the following amounts: 43 cents' worth; 36 cents' worth, 32 cents' worth.

42.  $54-24=\text{what?}$     $46-18=\text{what?}$     $41-22=\text{what?}$   
        $44-17=\text{what?}$     $45-26=\text{what?}$     $43-15=\text{what?}$   
        $47-28=\text{what?}$     $42-19=\text{what?}$     $40-27=\text{what?}$

NOTE.—These remainders may be conveniently found in the manner of counting change.

43. Read off the remainders in the following columns:—

From	26	27	29	31	35	36	37	41	44	45	50
Take	14	12	15	18	13	17	19	18	23	29	26
	—	—	—	—	—	—	—	—	—	—	—

## LESSON IX.

44. There are 52 trees in a grove. There are 32 elms and the rest are maples; how many maples are there?

45. A man traveled 58 miles in two days. The first day he went 22 miles; how many miles did he go the second day?

46. In a pile of 55 cords of wood there are 31 cords of maple, and the rest of the pile is beech; how many cords of beech wood are there?

47. There are 60 minutes in an hour; how many minutes of an hour remain after 25 minutes?

48. A man gave 67 dollars for two cows, giving for one of them 39 dollars; how many dollars did he give for the other?



49. A village lot is 66 feet wide. If the house occupies 33 feet of the width, how many feet remain?

50. A company consists of 74 ladies and gentlemen. If 34 are gentlemen, how many are ladies?

51. In 86 rods of fence, 49 rods are along the side of a field, and the rest across the end; how many rods wide is the field?

52. Mr. Smith, having 84 sheep, sold 46 of them; how many sheep had he left?

53. Ruth, having 75 cents, spent 40 cents for a book; how many cents had she remaining?

54. Out of a bin containing 87 bushels of wheat, a farmer sold 59 bushels; how many bushels remained?

55. A man gave 93 dollars for a horse and 54 dollars for a buggy. What was the difference of cost between the horse and the buggy?

56. From a company of 73 persons, 37 persons retired; how many remained?

57. A had 95 acres of land and B had 64 acres. What was the difference between A's number of acres and B's?

58. Read off the results in the following subtractions: —

From	58	60	67	66	74	73	86	84	93	95
Take	36	35	34	24	40	37	49	36	54	42
	—	—	—	—	—	—	—	—	—	—

59.  $64 - 23 =$  how many?  $69 - 35 =$  how many?

$56 - 40 =$  how many?  $79 - 42 =$  how many?

$73 - 46 =$  how many?  $94 - 47 =$  how many?

$85 - 55 =$  how many?  $82 - 58 =$  how many?

60. Count the change for a dollar on purchases to the following amounts: —

70 cents' worth;    78 cents' worth;    62 cents' worth;  
47 cents' worth;    41 cents' worth;    35 cents' worth.

## LESSON X.

1. A man collected 12 dollars of one man and 15 dollars of another. Out of this money he paid a debt of 10 dollars; how many dollars had he remaining?

2. A laborer received 30 dollars as his month's wages. Out of this he paid 12 dollars for his board and washing and 7 dollars for clothes; how many dollars had he left?

3. Henry, having 50 cents, spent 20 cents for a book, and 14 cents for a slate; how many cents had he remaining?

4. A man walked 23 miles one day and 26 miles the next; the third day he returned 25 miles; how far was he then from where he started the first day?

5. Mr. Jones bought a wagon for 25 dollars; he spent 12 dollars to get it repaired and painted, and then sold it for 43 dollars; how many dollars did he gain?

6. How many are,—

$$15+23-27? \quad 25-17+28? \quad 13+12+15-29?$$

$$33-14+25? \quad 34-19+22? \quad 18+16+10-30?$$

$$28+26-32? \quad 37+12-24? \quad 35-17+12-14?$$

7. An employer paid out 65 dollars to three workmen, A, B, and C. To A he paid 27 dollars and to B, 22 dollars; how many dollars did he pay to C?

8. Jennie wished to buy a music-book costing 75 cents. She used 30 cents of her own money and 25 cents that her brother lent her. Her mother made up what was lacking; how many cents did her mother give?

9. Bought an article costing 35 cents and one costing 47 cents; how many cents change should I receive for 1 dollar?

10. A boy having 83 doves sold 50 of them and then bought 32; how many doves did he then have?

11. A man bought two cows, one at 33 dollars and the other at 35 dollars. He sold them for 75 dollars; how many dollars did he gain?

12. A boy gave a dollar bill to pay for a book that cost 34 cents, a slate that cost 25 cents, and some paper that cost 18 cents; how much change should he receive?

13. What must be added to the sum of 27 and 46 to make 100?

14. What must be added to the difference between 50 and 24 to make 40?

15. How many more is the sum of 23 and 37 than the sum of 18 and 17?

16. How many less is the difference between 45 and 35 than the difference between 50 and 25?

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## LESSON XL

### MULTIPLICATION.

1. What will 2 apples cost at 2 cents each?

*Answer.*—2 apples at 2 cents each will cost 2 cents and 2 cents or 4 cents. Or, 2 apples at 2 cents each will cost 2 times 2 cents or 4 cents.

2. What will 2 peaches cost at 3 cents each?

*Answer.*—2 peaches at 3 cents each will cost 2 times 3 cents, or 6 cents.

3. How many are,—

2 times 2 cents?	2 times 5 days?	2 times 8 girls?
2 times 3 cents?	2 times 6 men?	2 times 9 books?
2 times 4 boys?	2 times 7 boys?	2 times 10 slates?

4. What will 3 pencils cost at 3 cents each?
5. How many are,—
 

3 times 3 cents?	3 times 6 days?	3 times 9 books?
3 times 4 cents?	3 times 7 men?	3 times 10 bushels?
3 times 5 cents?	3 times 8 dollars?	3 times 11 pounds?
6. At 4 cents each, what will 4 oranges cost?
7. What will be the cost of 4 bottles of ink at 5 cents apiece?
8. If a man can cut 6 cords of wood in a week, how many cords can he cut in 4 weeks?
9. How many are 4 times 7? 4 times 8? 4 times 9?
10. Five nickels are worth how many cents?

ANALYSIS.—One nickel is worth 5 cents, 5 nickels are worth 5 times 5 cents, or 25 cents.

11. There are 6 working days in a week; how many working days are there in 5 weeks?
12. How many are 5 times 7? 5 times 8? 5 times 9?
13. How many working days are there in 6 weeks?
14. How many are 6 times 7? 6 times 8? 6 times 9?
15. At 7 cents a quart, what will 7 quarts of berries cost?
16. What will 7 quarts of berries cost at 8 cents a quart? at 9 cents a quart?
17. There are 8 pints in a gallon; how many pints then are there in 8 gallons?
18. How many are 8 times 9 miles? How many are 9 times 9 feet?

19. How many are,—

2 times 2?	2 times 7?	3 times 4?	2 times 9?
2 times 6?	2 times 4?	2 times 8?	3 times 7?
5 times 1?	4 times 5?	3 times 6?	4 times 4?
2 times 3?	2 times 5?	3 times 8?	3 times 5?
3 times 7?	3 times 2?	5 times 5?	4 times 6?

20. How many are,—

3 times 9?	4 times 9?	6 times 7?	8 times 8?
5 times 6?	7 times 9?	5 times 9?	9 times 7?
4 times 7?	6 times 8?	4 times 8?	7 times 8?
5 times 8?	5 times 7?	8 times 9?	9 times 8?
6 times 6?	6 times 9?	7 times 7?	9 times 9?

**Multiplication** is the process of finding the result of taking one of two numbers as many times as there are ones in the other.

The number to be taken is called the *multiplicand*.

The number which expresses how many times the multiplicand is to be taken is called the *multiplier*.

The result obtained by multiplication is called the *product*?

The multiplicand and multiplier are called *factors* of the product.

The sign of multiplication is the symbol  $\times$  which is read "times" or "multiplied by," according as the multiplier is written at the left of the symbol or at the right. Thus, to express the multiplication of 7 days by 3, we may write  $3 \times 7$  days or  $7 \text{ days} \times 3$ . The first form would be read "3 times 7 days," the second form would be read "7 days multiplied by 3." In examples like  $7 \times 3$ , either form of reading may be used, preferably by use of the word times.

A number applied to an object or thing named is called a *concrete number*; a number not applied to an object or thing named is called an *abstract number*.

**Principles:**—

1. The multiplicand may be a concrete or an abstract number.
2. The multiplier must be an abstract number.
3. The product is a number of the same general kind as the multiplicand.

## LESSON XII.

## I. TABLE FOR DRILL.

$2 \times 6 = ?$	$3 \times 3 = ?$	$1 \times 5 = ?$	$3 \times 9 = ?$
$1 \times 8 = ?$	$6 \times 9 = ?$	$4 \times 7 = ?$	$3 \times 6 = ?$
$3 \times 7 = ?$	$7 \times 7 = ?$	$5 \times 6 = ?$	$3 \times 8 = ?$
$1 \times 9 = ?$	$4 \times 6 = ?$	$8 \times 9 = ?$	$2 \times 4 = ?$
$2 \times 3 = ?$	$3 \times 4 = ?$	$2 \times 1 = ?$	$4 \times 8 = ?$
$5 \times 5 = ?$	$6 \times 8 = ?$	$9 \times 9 = ?$	$7 \times 9 = ?$
$6 \times 1 = ?$	$1 \times 7 = ?$	$1 \times 1 = ?$	$4 \times 5 = ?$
$5 \times 8 = ?$	$4 \times 9 = ?$	$4 \times 4 = ?$	$6 \times 7 = ?$
$2 \times 8 = ?$	$1 \times 3 = ?$	$2 \times 7 = ?$	$7 \times 8 = ?$
$4 \times 1 = ?$	$5 \times 9 = ?$	$5 \times 7 = ?$	$8 \times 8 = ?$
$2 \times 9 = ?$	$3 \times 5 = ?$	$2 \times 2 = ?$	$2 \times 5 = ?$

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## LESSON XIII.

## II. TABLE FOR DRILL.

$2 \times 12 = ?$	$5 \times 10 = ?$	$8 \times 12 = ?$	$9 \times 10 = ?$
$4 \times 12 = ?$	$3 \times 10 = ?$	$2 \times 11 = ?$	$2 \times 10 = ?$
$11 \times 12 = ?$	$6 \times 10 = ?$	$8 \times 10 = ?$	$10 \times 10 = ?$
$7 \times 11 = ?$	$4 \times 10 = ?$	$4 \times 11 = ?$	$10 \times 12 = ?$
$6 \times 11 = ?$	$5 \times 12 = ?$	$10 \times 11 = ?$	$9 \times 12 = ?$
$8 \times 11 = ?$	$3 \times 12 = ?$	$7 \times 10 = ?$	$6 \times 12 = ?$
$7 \times 12 = ?$	$9 \times 11 = ?$	$11 \times 11 = ?$	$3 \times 11 = ?$
$5 \times 11 = ?$	$12 \times 12 = ?$	$2 \times 13 = ?$	$2 \times 17 = ?$
$2 \times 15 = ?$	$2 \times 14 = ?$	$3 \times 16 = ?$	$3 \times 15 = ?$
$2 \times 19 = ?$	$4 \times 15 = ?$	$1 \times 18 = ?$	$3 \times 18 = ?$
$3 \times 13 = ?$	$2 \times 16 = ?$	$3 \times 14 = ?$	$4 \times 13 = ?$

## LESSON XIV.

1. What will 7 barrels of flour cost at 8 dollars a barrel?
2. How many miles can a man ride in 6 hours at the rate of 9 miles an hour?
3. There are 9 square feet in a square yard; how many square feet are there in 9 square yards?
4. What will 6 tons of coal cost at 8 dollars a ton?
5. There are 8 rows of trees in an orchard and 9 trees in a row; how many trees are there in the orchard?
6. How many days are there in 5 weeks?
7. How many months are there in 9 years?
8. If a man works 10 hours a day, how many hours will he work in 6 days?
9. There are eight pints in a gallon; how many pints are there in 12 gallons?

ANALYSIS.—In one gallon there are eight pints; in 12 gallons there are 12 times 8 pints, or 96 pints.

10. How many working days are there in 11 weeks?
11. What will 12 cords of wood cost at 4 dollars a cord?
12. What will 10 tons of hay cost at 7 dollars a ton?
13. What will 9 pairs of pants cost at 5 dollars a pair?
14. At the rate of 10 cents a dozen, what will 12 dozen eggs cost?
15. A farmer sold 11 tons of hay at 8 dollars a ton; how many dollars did he receive?
16. Two men start at the same time and travel in opposite directions from a certain place, one at the rate of 3 miles an hour and the other at the rate of 4 miles an hour; how far apart will they be at the end of 12 hours?

17. How many dollars will a man receive for 11 weeks' work at 9 dollars a week?

18. What will 7 barrels of pork cost at 9 dollars a barrel?

19. There were 12 boys in a certain school, and 5 times as many girls as boys; how many pupils were there in the school?

20. If 9 men can do a piece of work in 10 days, how long would it take 1 man to do it?

21. There are 8 rows of trees and 8 trees in a row; how many trees in all?

22. In 12 dozen eggs how many eggs?

23. What would 7 quarts of berries cost at 6 cents a quart?

24. How long would it take 1 man to do a piece of work that 11 men could do in 11 days?

25. In 12 dozen eggs there were 12 bad ones; how many were good?

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## LESSON XV.

1. How many are 2 times 23? 3 times 23?

ANALYSIS.—23 is  $20+3$ ; 2 times 23 is 2 times  $20+2$  times 3; 2 times 20 is 40 and 2 times 3 is 6; so 2 times 23 is  $40+6$  or, 46.

2. How many are 2 times 24? 3 times 24?

3. How many are 2 times 32? 3 times 32?  $32 \times 4$ ?

4. How many are,—

$23 \times 2?$

$23 \times 3?$

$23 \times 4?$

$23 \times 5?$

$24 \times 2?$

$24 \times 3?$

$24 \times 4?$

$24 \times 5?$

$25 \times 2?$

$25 \times 3?$

$25 \times 4?$

$25 \times 5?$



Multiply —

5.	34 by 2	34 by 4	36 by 4	36 by 5
	42 by 2	42 by 3	42 by 4	42 by 5
	16 by 2	16 by 3	26 by 3	36 by 2
6.	$15 \times 4 = ?$	$13 \times 4 = ?$	$14 \times 4 = ?$	$14 \times 5 = ?$
	$17 \times 2 = ?$	$17 \times 3 = ?$	$17 \times 4 = ?$	$17 \times 5 = ?$
	$18 \times 2 = ?$	$18 \times 3 = ?$	$19 \times 4 = ?$	$19 \times 5 = ?$

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## LESSON XVI.

1. What will 4 cows cost at 14 dollars each?
2. How many dollars would a man receive for 2 months' work at 18 dollars a month?
3. What will be the cost of 4 pounds of butter at 15 cents a pound?
4. What will 5 acres of land cost at 18 dollars an acre?
5. There are 13 weeks in one fourth of a year; how many weeks in one year?
6. There are 3 feet in a yard; how many feet are there in 16 yards?
7. What will 17 sheep cost at 2 dollars a head?
8. Three boys had 14 cents each; how many cents did they all have together?
9. At 2 dollars a day, how many dollars may be earned in 19 days?
10. How many feet are there in 17 yards?
11. What will 2 slates cost at 15 cents apiece?
12. How far can a man travel in 20 hours at the rate of 5 miles an hour?

13. Willie has 13 cents and Henry has 3 times as many; how many cents has Henry?

14. Two men start out together and travel in the same direction. One of them rides at the rate of 6 miles an hour and the other walks at the rate of 4 miles an hour; how far apart will they be at the end of 14 hours?

15. A pound of butter weighs 16 ounces; how many ounces will 4 pounds weigh?

16. What will 5 dozen bananas cost at 15 cents a dozen?

17. How long will it take one man to do a piece of work that 2 men can do in 16 days?

18. A tailor made 14 coats, each requiring 5 yards of cloth; how many yards did he use?

19. Susan used a 50-cent piece to pay for 15 yards of ribbon at 3 cents a yard; how many cents should she receive in change?

20. If railroad fare is 3 cents a mile, what would be the cost of a ticket to ride 20 miles?

21. What would 2 thousand feet of lumber cost at 13 dollars a thousand?

22. Two brothers each earn 8 cents a day by selling papers; how many cents will they together earn in 5 days?

23. A drover bought 3 cows at 18 dollars each, and sold them for 60 dollars; how many dollars did he gain?

24. A young man receives 18 dollars a month as wages. He pays 3 dollars a month for his board, and his other expenses average 2 dollars a month; how many dollars will he save in 5 months?

25. What will be the cost of 18 cords of wood at 4 dollars a cord?

26. What will 6 pounds of butter cost at 15 cents a pound?

27. How long will it take one man to do as much work as 7 men can do in 13 hours?

28. A man agreed to work 24 days at 3 dollars a day, but he lost 5 days by sickness; how many dollars should he receive?

29. A teacher's salary was 32 dollars a month. She paid 3 dollars a week for board and 3 dollars a month for other expenses; how many dollars could she save in a 4-month term?

30. A farmer had 25 hogs. He reserved 6 of them for his own use, and sold the remainder at 4 dollars apiece; how many dollars did they bring him?

31. Jennie can pick 8 quarts of berries in an hour, and Mary can pick 6 quarts; how many quarts can they together pick in 6 hours?

32. If street-car fare is 5 cents, how many cents will 19 rides cost?

33. In a certain orchard there are 7 rows of trees and twice as many trees in a row as there are rows; how many trees are there in the orchard?

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## LESSON XVII.

### DIVISION.

1. How many times are 2 dollars contained in 10 dollars?

ANALYSIS.— Since 5 times 2 dollars are 10 dollars, 2 dollars are contained 5 times in 10 dollars.

2. How many times are 5 bushels contained in 35 bushels?

3. How many times are 7 pounds contained in 56 pounds?

4. How many packages of 4 pounds each can be made of 36 pounds of raisins?

5. If a family consumes 6 pounds of flour each day, how many days will 42 pounds last?

6. When coal is worth 8 dollars a ton, how many tons can be bought for 40 dollars?

7. At 9 dollars a week, how many weeks will it take to earn 72 dollars?

8. How many weeks are there in 63 days?

9. In an orchard of 48 trees, there are 8 trees in a row; how many rows are there?

10. Bought 54 pounds of coffee in 6-pound packages, how many packages were there?

11. Paid 72 dollars for hay, at the rate of 8 dollars a ton; how many tons were there?

12. A man paid 45 dollars for wood, at 5 dollars a cord; how many cords did he buy?

13. If 9 yards of cloth are required to make a suit of clothes, how many such suits may be made of 36 yards?

14. At 7 miles an hour, how many hours will it take to drive 49 miles?

15. How many bushels of clover-seed at 4 dollars a bushel may be bought for 32 dollars?

16. Paid 81 cents for eggs at 9 cents a dozen; how many dozen did I buy?

17. If a man can do a piece of work in 64 days, how many men will it take to do the same amount of work in 8 days?

18. How many weeks will it take to cut 63 cords of wood at the rate of 9 cords a week?

19. How many gallons are there in 56 quarts?

20. A farmer received 45 dollars for hay at the rate of 9 dollars a ton; how many tons did he sell?

21. How many groups of 6 persons each can be made from a company of 36 persons? from a company of 48 persons?

22. How many fields of 9 acres each may be made of 54 acres? of 72 acres?

23. In a company of 40 ladies and gentlemen, there was 1 gentleman to every 7 ladies; how many gentlemen were there?

24. How many nickels are worth 40 cents?

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## LESSON XVIII.

1. If 24 dollars are equally divided between 2 men, how many dollars will each man receive?

ANALYSIS.— If 24 dollars are equally divided among 2 men, each man will receive one half of 24 dollars, or 12 dollars.

2. If 30 pupils are divided into 3 equal classes, how many pupils will there be in each class?

*Answer.— There will be in each class one third of 30 pupils, or 10 pupils.*

3. If 28 acres of land are divided into 4 equal fields, how many acres will each field contain?

4. What is one fifth of 55 miles? of 70 miles? of 100 miles?

5. A dairyman put 60 pounds of butter into 6 equal-sized crocks; how many pounds did he put in each crock?

6. In an orchard of 84 trees there are 7 rows; how many trees were there in a row?

7. A farmer exchanged 18 cords of wood at 4 dollars a cord for 8 tons of hay; what was the cost of the hay per ton?

8. If it takes 6 men 15 days to do a piece of work, how many days would it take 9 men?

9. A farmer took 10 pounds of sugar in exchange for 5 pounds of butter at 14 cents a pound; what was the price of the sugar per pound?

10. A man had to drive 75 miles. He drove the first 20 miles at the rate of 4 miles an hour. At what rate per hour must he drive the rest of the distance to complete the trip in 16 hours from the time of starting?

11. A man owing 100 dollars paid 28 dollars in cash, and the balance in flour at 6 dollars a barrel; how many barrels of flour did it take?

12. A farmer had 30 sheep. He kept one half of them and sold the remainder for 90 dollars; how many dollars a head did he receive for the sheep sold?

13. Two men 80 miles apart, start at the same time to travel toward each other, one at the rate of 7 miles and the other at the rate of 9 miles an hour; in how many hours will they meet?

14. If I sell 5 pounds of butter for 85 cents, what do I receive per pound?

15. If it takes 90 bushels of oats to feed 18 horses for one month, how many horses will consume 65 bushels in the same time?

16. Bought 2 books at 20 cents each, and 14 pencils. Paid a dollar and received 4 cents in change; how many cents apiece were the pencils?

17. At what price per day will a man receive 57 dollars for 19 days' work?

18. At the rate of 20 pounds of sugar for a dollar, how many pounds of sugar can be bought for 65 cents?

19. If a man can walk 72 miles in 18 hours, in how many hours can he walk 56 miles?

20. A young man rode 60 miles on his wheel at the rate of 15 miles an hour. He rested a while, and then returned at the rate of 12 miles an hour, having been gone 10 hours; how long did he rest?

**Division** is the process of finding how many times one number is contained in another, also the process of finding one of the equal parts of a number.

The number to be divided is called the *dividend*; the number by which the dividend is divided is called the *divisor*. The number found by division is called the *quotient*.

The sign of division is the symbol  $\div$ . In expressing division by the use of the sign, the dividend is written at the left of the sign and the divisor at the right. Thus, to express the division of 6 by 2, we write  $6 \div 2$ .

**Principles:—**

1. The dividend may be a concrete, or an abstract number.

2. The divisor may be a concrete number of the same kind as the dividend, or an abstract number.

3. The quotient may be an abstract number, or a concrete number of the same general kind as the dividend.

$$21. 35 \div 5 = ? \quad 48 \div 6 = ? \quad 54 \div 9 = ? \quad 65 \div 5 = ?$$

$$22. 72 \div 4 = ? \quad 75 \div 15 = ? \quad 90 \div 6 = ? \quad 85 \div 17 = ?$$

What is the quotient,—

23. Of the sum  $14 + 16 \div 10$ ? of the sum  $23 + 21 \div 11$ ? of the sum  $22 + 23 \div 15$ ?

24. Of the remainder  $90 - 12 \div 13$ ? of the remainder  $76 - 19 \div 19$ ? of the remainder  $82 - 14 \div 17$ ?

25. Of the product  $8 \times 12 \div 16$ ? of the product  $5 \times 18 \div 15$ ? of the product  $8 \times 9 \div 18$ ? of the quotient  $90 \div 5 \div 3$ ?

## LESSON XIX.

## MISCELLANEOUS PROBLEMS.

1. A grocer bought 12 quarts of berries at 5 cents a quart, and 10 quarts at 6 cents a quart. He sold them all at 7 cents a quart; how many cents did he gain?

2. A man having 56 miles to travel, went 20 miles the first day, and finished his journey in 9 hours on the second day; how many miles an hour did he travel on the second day? How many hours did he travel on the first day at that rate?

3. A farmer sold 18 cords of wood at 4 dollars a cord, and with the money bought 3 tons of hay at 8 dollars a ton, and some sheep at 3 dollars a head; how many sheep did he buy?

4. How many pounds of sugar at 6 cents a pound may be bought with 9 dozen eggs at 10 cents a dozen?

5. John has 75 cents. How many cents more will he require to pay 50 cents for an arithmetic, 20 cents for a slate, and for two quires of paper at 12 cents a quire?

6. William bought 40 apples at the rate of 5 for 6 cents and exchanged them for peaches costing 3 cents apiece; how many peaches did he get?

7. A farmer having 62 lambs sold 30 of them for 4 dollars a head and the remainder at 5 dollars a head; how many dollars did he receive for all?

8. Which is better, to sell 8 quarts of berries for 40 cents, or to sell 6 quarts for 42 cents? How much better?

9. In a certain school there are 23 boys and 3 times as many girls lacking 19; how many pupils are in the school?

10. If a coach runs 63 miles in 9 hours, in how many hours will it run 84 miles?



11. A contractor paid his foreman 4 dollars a day and paid each of 4 other men 3 dollars a day; how many dollars did he pay for one week's work?

12. Henry rode 6 hours at the rate of 10 miles an hour and walked back at the rate of 4 miles an hour; how many hours was he in walking back?

13. 50 is 8 more than 3 times what number?

14. 50 is 10 less than 4 times what number?

15. James and John start together to walk in opposite directions. James walks at the rate of 4 miles an hour and John at the rate of 3 miles an hour; how far apart will they be at the end of 10 hours? How many miles will each then have walked?

16. Bought 9 tons of coal at 8 dollars a ton, and gave 20 cords of wood at 3 dollars a cord and the rest in cash; how much cash did I give?

17. A man had a 50-dollar note, a 20-dollar note, and a 10-dollar note. How many dollars had he left after paying for 15 sheep at 5 dollars a head?

18. A woman sold a grocer 5 dozen eggs at 10 cents a dozen, and four pounds of butter at 15 cents a pound. She paid the grocer 75 cents she was owing him, and took the balance in sugar at 5 cents a pound; how many pounds of sugar did she receive?

19. In a certain subtraction the remainder was 23, and the subtrahend was 3 times the remainder; what was the minuend?

20. What number on being divided by 9 gives a quotient 7 and a remainder 7?

21. Bought 16 barrels of flour at 5 dollars a barrel. Sold 12 barrels at 6 dollars each and kept the remainder at cost for my own use; what did I gain?

22. Paid 75 dollars for 15 barrels of flour. At what price per barrel should I sell to gain 15 dollars?

23. Four times a certain number is 68; what is 5 times the same number?

24. A newsboy bought 10 papers for 25 cents, and sold them so as to gain 15 cents; how many cents did he get apiece for them?

25. A watch and chain are together worth 50 dollars, and the watch is worth 30 dollars more than the chain; what is the worth of each?

26. A horse is worth 15 times as much as the harness upon him, but the horse and harness together are worth 80 dollars; what is the horse worth?

## LESSON XX.

### PRIME AND COMPOSITE NUMBERS.

*a.*

$$1=1\times 1$$

$$2=2\times 1$$

$$3=3\times 1$$

$$5=5\times 1$$

$$7=7\times 1$$

etc.

*b.*

$$4=4\times 1 \text{ or } 2\times 2$$

$$6=6\times 1 \text{ or } 3\times 2$$

$$8=8\times 1 \text{ or } 4\times 2 \text{ or } 2\times 2\times 2$$

$$9=9\times 1 \text{ or } 3\times 3$$

$$10=10\times 1 \text{ or } 5\times 2$$

etc.

Comparing columns *a* and *b*, we notice that they distinguish two classes of numbers. The numbers in column *a* have no other factors than the numbers themselves and 1. The numbers in column *b* have other factors besides the numbers themselves and 1. A number that has no other factors except the number itself and 1 is called a *prime number*; and a number that has other factors besides the number itself and 1 is called a *composite number*.

Of the first ten numbers, one half of them are prime numbers, and one half are composite numbers.

EXERCISES.— Name the prime numbers, —

1. Beginning with 11 and ending with 20.
2. Beginning with 21 and ending with 30.
3. Beginning with 31 and ending with 40.
4. Beginning with 41 and ending with 50.
5. Beginning with 51 and ending with 100.
6. Beginning with 1 and ending with 100.
7. Name the composite numbers to 100.
8. Make written lists of the prime and composite numbers from 1 to 100. Of which kind are there the greater number?

## LESSON XXI.

### FACTORING.

1. What are the prime factors of 12?

OPERATION.— We begin with 12 as a known product of 3 and 4, and as 4 is a composite factor, we resolve it into the prime factors 2 and 2. We thus find the prime factors of 12 to be 2, 2, and 3.

2. What are the prime factors, —

Of 14?	Of 15?	Of 16?	Of 28?	Of 99?
Of 18?	Of 21?	Of 20?	Of 56?	Of 100?
Of 25?	Of 27?	Of 22?	Of 72?	Of 108?
Of 30?	Of 36?	Of 35?	Of 84?	Of 110?
Of 32?	Of 44?	Of 24?	Of 54?	Of 120?
Of 40?	Of 49?	Of 42?	Of 96?	Of 121?
Of 45?	Of 63?	Of 33?	Of 88?	Of 132?
Of 48?	Of 64?	Of 66?	Of 77?	Of 144?
Of 50?	Of 70?	Of 80?	Of 60?	Of 150?

## LESSON XXII.

### DIVISORS AND MULTIPLES.

The exact divisors,—

Of 6 are 1, 2, 3, and 6.

Of 8 are 1, 2, 4, and 8.

Of 10 are 1, 2, 5, and 10.

Of 12 are 1, 2, 3, 4, 6, and 12.

What are the exact divisors,—

1. Of 14?
2. Of 15?
3. Of 16?
4. Of 18?
5. Of 20?

6. What divisors of 6 are divisors also of 8?

7. What divisors of 6 are divisors also of 12?

8. What divisors of 8 are divisors also of 12?

A number which exactly divides each of two or more numbers is called a *common divisor* of the numbers; and the largest common divisor of numbers is called their *greatest common divisor*.

9. What are the common divisors of 8, 12, and 20? of 8 and 16? of 10 and 20?

10. What is the greatest common divisor of 12 and 20? of 8 and 16? of 10 and 20?

The products,—

Of 2 are 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, etc.

Of 3 are 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, etc.

Of 4 are 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, etc.

What are the products,—

1. Of 5 to 50?
2. Of 6 to 60?
3. Of 7 to 70?
4. Of 8 to 80?

5. What products of 2 are products also of 3 up to 20?
6. What products of 3 are products also of 4 up to 30?
7. What products of 2 are products also of 4 up to 20?

A product of a number is called a *multiple* of the number.

A number which is a multiple of each of two or more numbers is called a *common multiple* of them; and the smallest common multiple of numbers is called their *least common multiple*.

8. What are the common multiples of 2 and 3 up to 20? What is the least one?
9. What are the common multiples of 3 and 4 up to 30? What is the least one?
10. What are the common multiples of 2, 3, and 4 up to 30? What is the least one?
11. What is the greatest common divisor of 12, 18, and 24? of 9, 12, and 15?
12. What is the greatest common divisor of 8, 24, and 40? of 30, 45, and 75?
13. What is the least common multiple of 4 5 and 6? of 3, 4, and 5?

**Principles :—**

1. The greatest common divisor of numbers is the product of the common prime factors of the numbers.

Thus, the prime factors of 30 being 2, 3, and 5, and the prime factors of 45 being 3, 3, and 5, the greatest common divisor of 30 and 45 is  $3 \times 5$ , or 15.

2. The least common multiple of numbers is the smallest number that contains all the prime factors of each number. Thus of 30 and 45, the least common multiple is  $2 \times 3 \times 3 \times 5$ , or 90.

## LESSON XXIII.

## FRACTIONS.

**Formation of Fractions.**—If the unit *1* be divided into two equal parts, one of the parts is treated as a unit called *one half*—written  $\frac{1}{2}$ .

One of the three equal parts of the unit *1* is a unit called *one third*—written  $\frac{1}{3}$ ; and one of the four equal parts of the unit *1* is a unit called *one fourth*—written  $\frac{1}{4}$ .

Units formed in this manner are called *fractional units*; and numbers whose units are fractional are called *fractions*.

The unit that is divided into equal parts in forming a fractional unit is called an *integral unit*, or *unit of the fraction*.

Fractions are expressed by use of two figures, one written just above the other with a short line between them, thus  $\frac{3}{4}$ .

The number above the line is the *numerator* of the fraction, and the number below the line is the *denominator*.

The numerator of a fraction shows the number of fractional units of which the fraction is formed; and the denominator of a fraction shows the number of equal parts into which the integral unit is divided in forming the fractional unit.

The numerator and denominator together are called the *terms* of the fraction.

A fraction, as  $\frac{2}{3}$ , whose numerator is less than its denominator is called a *proper* fraction; and a fraction, as  $\frac{3}{3}$  or  $\frac{5}{3}$ , whose numerator is equal to, or greater than, its denominator is called an *improper* fraction.

A number, as  $3\frac{1}{4}$ , composed of an integer and a fraction united in expression is called a *mixed number*.

Describe the manner of forming the fraction  $\frac{3}{8}$  of a bushel.

DESCRIPTION.—The fraction  $\frac{3}{8}$  of a bushel is formed by dividing the unit 1 bushel into 8 equal parts to form the fractional unit  $\frac{1}{8}$  of a bushel. Then a collection of 3 of this fractional unit forms the fraction  $\frac{3}{8}$  of a bushel.

Describe the formation of the following fractions:—

1.  $\frac{5}{12}$  of a day.
2.  $\frac{4}{5}$  of a dollar.
3.  $\frac{7}{8}$  of a pound.
4.  $\frac{3}{16}$  of a cord.
5.  $\frac{3}{10}$  of an acre.
6.  $\frac{11}{10}$  of a mile.
7.  $\frac{13}{8}$ ;  $2\frac{1}{2}$ ;  $6\frac{2}{3}$ .
8.  $\frac{5}{16}$ ;  $\frac{3}{4}$  of  $\frac{2}{11}$ .
9.  $\frac{23}{8}$ ;  $\frac{2}{3}$  of  $\frac{5}{7}$ .

## LESSON XXIV.

1. If a pound of butter cost 20 cents, how many cents will  $\frac{1}{4}$  of a pound cost?

ANALYSIS.—Since 1 pound of butter costs 20 cents,  $\frac{1}{4}$  of a pound will cost  $\frac{1}{4}$  of 20 cents, or 4 cents; and as  $\frac{1}{4}$  of a pound costs 4 cents,  $\frac{1}{4}$  of a pound will cost 4 times 4 cents, or 16 cents.

2. If a boy earns 75 cents in 1 day, how many cents will he earn in  $\frac{2}{3}$  of a day?

3. John has 40 cents and James has  $\frac{5}{8}$  as many cents as John; how many cents has James?

4. If a dozen oranges cost 30 cents, how many cents will  $\frac{2}{3}$  of a dozen cost?

5. A boy paid 60 cents for a book and  $\frac{2}{3}$  as many cents for a slate; how many cents did he pay for the slate?

6. A piece of ground is 80 feet long and the width is  $\frac{3}{4}$  of the length; how wide is it?

7. In a company of 45 boys and girls, the number of boys is  $\frac{2}{3}$  of the company; how many girls are there?

8. There are 52 weeks in a year; how many weeks are there in  $\frac{3}{4}$  of a year?

9. A man is 54 years old. His wife is  $\frac{2}{3}$  as old as he, and his son is  $\frac{2}{3}$  as old as his mother; what are the ages of the wife and the son?

10. A bin that will hold 65 bushels is  $\frac{4}{5}$  full; how many bushels are there in the bin?

11. A man gave \$50 for a watch, and gave for a chain  $\frac{3}{10}$  as many dollars as for the watch; what did he give for both?

12. A man having 80 miles to travel went  $\frac{3}{8}$  of  $\frac{3}{8}$  of the distance the first day and the remainder the second day; what distance did he travel each day?

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## LESSON XXV.

### COMPARISON OF FRACTIONS.

1. An apple can be divided into how many halves? into how many fourths? into how many thirds? into how many sixths?

2. Which is the larger, one half of a thing or one fourth of it? Give reason.

3. Which is the larger, one fourth of a thing or one third of it? Give reason.

4. How many fourths of a thing are there in one half of it? Show why.

5. How many sixths of a thing are there in one half of it? In one third of it?

6. Two thirds of anything are how many sixths of it?

7. One half of a thing is how many eighths of it? How many tenths of it? How many twelfths of it?

8. Suppose a line to be divided into 12 equal parts. How many of these equal parts would be in  $\frac{1}{3}$  of the line?



In  $\frac{1}{3}$  of the line?In  $\frac{1}{4}$  of the line?In  $\frac{1}{5}$  of the line?In  $\frac{1}{5}$  of the line?In  $\frac{1}{6}$  of the line?In  $\frac{1}{6}$  of the line?

9. If an apple be divided into eighteen equal parts, how many of those parts would there be in  $\frac{1}{3}$  of the apple?

In  $\frac{1}{3}$  of it?In  $\frac{2}{3}$  of it?In  $\frac{1}{4}$  of it?In  $\frac{3}{4}$  of it?In  $\frac{1}{5}$  of it?In  $\frac{4}{5}$  of it?In  $\frac{1}{6}$  of it?In  $\frac{5}{6}$  of it?

10. Which is the larger part of an apple,  $\frac{2}{3}$  of it or  $\frac{3}{4}$  of it?  $\frac{2}{3}$  of it or  $\frac{4}{5}$  of it?

11. If anything be divided into 10 equal parts, how many of the parts would there be in  $\frac{1}{3}$  of the thing? in  $\frac{1}{4}$  of it? in  $\frac{2}{5}$  of it? in  $\frac{3}{5}$  of it?

12. Divide something, for example a line, into 20 equal parts, and, by counting parts, find which is the larger,  $\frac{3}{4}$  or  $\frac{2}{3}$ ;  $\frac{1}{4}$  or  $\frac{3}{10}$ ;  $\frac{1}{5}$  or  $\frac{5}{10}$ .

## LESSON XXVI.

### REDUCTION OF FRACTIONS.

#### 1. To Higher Fractional Unit.—

Reduce  $\frac{2}{3}$  to fourths.

ANALYSIS.—Since there are  $\frac{2}{3}$  in  $\frac{1}{4}$ , there are as many fourths in  $\frac{2}{3}$  as 2 is contained times in 6, or  $\frac{4}{3}$ .

1. Reduce  $\frac{3}{4}$  to fifths. *Question.* How many fifteenths equal  $\frac{1}{4}$ ?

2. Reduce  $\frac{1}{3}$  to thirds. *Question.* How many eighths equal  $\frac{1}{3}$ ?

3. Reduce  $\frac{2}{3}$  to sevenths. 4. Reduce  $\frac{3}{4}$  to fifths.

5. Reduce  $\frac{9}{27}$  to thirds.
6. Reduce  $\frac{9}{12}$  to fourths.
7. Reduce  $\frac{2}{3}$  to thirds.
8. Reduce  $\frac{1}{6}$  to fifths.
9. Reduce  $\frac{4}{6}$  to twelfths.
10. Reduce  $\frac{6}{20}$  to tenths.
11. How many halves in  $\frac{7}{4}$ ? in  $\frac{9}{8}$ ? in  $\frac{5}{10}$ ?
12. How many thirds in  $\frac{4}{3}$ ? in  $\frac{4}{2}$ ? in  $\frac{7}{3}$ ?
13. How many fourths in  $\frac{9}{2}$ ? in  $\frac{8}{8}$ ? in  $\frac{8}{4}$ ?
14. How many fifths in  $\frac{2}{5}$ ? in  $\frac{2}{10}$ ? in  $\frac{2}{5}$ ?
15. How many sixths in  $\frac{4}{3}$ ? in  $\frac{5}{6}$ ? in  $\frac{1}{4}$ ?

Reduce  $\frac{1}{3}$  to lowest terms.

OPERATION.—It is seen that 3 is a common factor of the terms of the given fraction. Dividing the terms of the fraction by 3 we obtain  $\frac{1}{3}$ , which is the result sought.

ANALYSIS.—The fractional unit  $\frac{1}{3}$  is 3 times the fractional unit  $\frac{1}{9}$ ; whence the number of fifths required to equal  $\frac{1}{3}$  is  $\frac{1}{3}$  of 12, or 4. Thus,  $\frac{1}{3} = \frac{4}{12}$ .

NOTE.—A fraction is in its lowest terms when its numerator and denominator have no common factor.

Reduce to lowest terms,—

- |                     |                      |                      |                     |                     |                      |
|---------------------|----------------------|----------------------|---------------------|---------------------|----------------------|
| 1. $\frac{9}{27}$ . | 2. $\frac{15}{25}$ . | 3. $\frac{16}{24}$ . | 4. $\frac{8}{20}$ . | 5. $\frac{1}{3}$ .  | 6. $\frac{15}{40}$ . |
| 7. $\frac{1}{3}$ .  | 8. $\frac{2}{5}$ .   | 9. $\frac{1}{2}$ .   | 10. $\frac{1}{2}$ . | 11. $\frac{1}{3}$ . | 12. $\frac{2}{8}$ .  |
| 13. $\frac{2}{5}$ . | 14. $\frac{1}{4}$ .  | 15. $\frac{8}{40}$ . | 16. $\frac{1}{3}$ . | 17. $\frac{2}{5}$ . | 18. $\frac{2}{7}$ .  |

## LESSON XXVII.

Reduce  $\frac{1}{3}$  to an integer.

ANALYSIS.— $\frac{1}{3}$  equals 1;  $\frac{1}{3}$  equals as many ones as 3 is contained times in 15, or 5.

Reduce  $\frac{1}{6}$  to a mixed number.

ANALYSIS.— $\frac{1}{6}$  equals 1;  $\frac{1}{6}$  equals as many ones as 5 is contained times in 18, or  $3\frac{1}{2}$ .

Reduce to integers or mixed numbers,—

1.  $\frac{9}{3}$ .    2.  $\frac{25}{6}$ .    3.  $\frac{49}{4}$ .    4.  $\frac{60}{10}$ .    5.  $\frac{72}{6}$ .    6.  $\frac{100}{10}$ .  
 7.  $\frac{38}{7}$ .    8.  $\frac{29}{6}$ .    9.  $\frac{23}{4}$ .    10.  $\frac{32}{6}$ .    11.  $\frac{44}{4}$ .    12.  $\frac{43}{8}$ .

## LESSON XXVIII.

### 2. To Lower Fractional Unit.—

Reduce 5 to fourths.    Reduce  $3\frac{1}{4}$  to sevenths.

ANALYSIS.— There are  $\frac{1}{4}$  in 1; in 5 there are 5 times  $\frac{1}{4}$ , or  $\frac{5}{4}$ .  
 In 3 are  $\frac{3}{4}$ ; in  $3\frac{1}{4}$  there are  $\frac{3}{4} + \frac{1}{4}$ , or  $\frac{4}{4}$ .

Reduce to improper fractions,—

- a.  $5\frac{1}{2}$ .    b.  $8\frac{3}{10}$ .    c.  $12\frac{1}{4}$ .    d.  $15\frac{3}{4}$ .    e.  $20\frac{3}{8}$ .

Reduce  $\frac{2}{3}$  to twelfths.

ANALYSIS.— In  $\frac{1}{3}$  there are  $\frac{1}{12}$  and in  $\frac{2}{3}$  there are 2 times  $\frac{1}{12}$ , or  $\frac{2}{12}$ .

1. Reduce  $\frac{3}{5}$  to fifteenths.    *Question.* How many fifteenths in  $\frac{1}{5}$ ?

2. Reduce  $\frac{4}{5}$  to thirty-fifths.    *Question.* How many thirty-fifths in  $\frac{1}{5}$ ?

3. Reduce  $\frac{2}{5}$  to twentieths.    4. Reduce  $\frac{5}{6}$  to eighteenths.

5. Reduce  $\frac{5}{6}$  to sixteenths; to fortieths; to fifty-sixths.

6. Reduce  $\frac{3}{4}$  to eighths; to twenty-fourths; to fortieths.

7.  $\frac{2}{3} = \frac{8}{12} = \frac{16}{24} = \frac{24}{36} = \frac{32}{48} = \frac{40}{60} = \frac{48}{72}$ .

8.  $\frac{1}{3} = \frac{1}{12} = \frac{2}{24} = \frac{3}{36} = \frac{4}{48} = \frac{5}{60} = \frac{6}{72}$ .

9. How many twentieths in  $\frac{1}{2}$ ? in  $\frac{3}{4}$ ? in  $\frac{4}{5}$ ?

10. How many twenty-fourths in  $\frac{1}{3}$ ? in  $\frac{2}{3}$ ? in  $\frac{1}{4}$ ? in  $\frac{3}{8}$ ?

11. How many thirtieths in  $\frac{2}{3}$ ? in  $\frac{5}{6}$ ? in  $\frac{3}{10}$ ? in  $\frac{2}{15}$ ?

12. How many thirty-sixths in  $\frac{4}{9}$ ? in  $\frac{1}{3}$ ? in  $\frac{3}{4}$ ? in  $\frac{5}{18}$ ?

13. Reduce  $\frac{1}{2}$ ,  $\frac{2}{3}$ , and  $\frac{3}{4}$  each to twelfths.

14. Reduce  $\frac{3}{10}$ ,  $\frac{2}{5}$ , and  $\frac{5}{6}$  each to thirtieths

15. Reduce  $\frac{1}{2}$ ,  $\frac{2}{10}$ , and  $\frac{3}{8}$  each to fortieths.
16. Reduce  $\frac{1}{2}$ ,  $\frac{2}{3}$ ,  $\frac{5}{6}$ , and  $\frac{7}{15}$  to fractions having the smallest like denominators.
17. Reduce  $\frac{2}{3}$ ,  $\frac{1}{4}$ ,  $\frac{3}{8}$ , and  $\frac{5}{12}$  to fractions having the smallest like denominators.
18. Reduce  $\frac{2}{3}$ ,  $\frac{4}{15}$ ,  $\frac{7}{30}$ , and  $\frac{3}{10}$  to least common denominator.
19. Reduce  $\frac{1}{2}$ ,  $\frac{5}{8}$ ,  $\frac{3}{4}$ , and  $\frac{2}{3}$  to least common denominator.
20. Reduce  $\frac{1}{2}$ ,  $\frac{1}{3}$ ,  $\frac{1}{4}$ , and  $\frac{1}{6}$  to least common denominator.

## LESSON XXIX.

### REVIEW OF REDUCTION.

Analyze,—

1.  $\frac{3}{8}$  of 40.    2.  $\frac{4}{5}$  of 35.    3.  $\frac{5}{7}$  of 56.    4.  $\frac{7}{9}$  of 45.
5.  $\frac{4}{7}$  of 42 is how many times 3?
6.  $\frac{3}{8}$  of 54 is how many times 12?
7.  $\frac{4}{5}$  of 70 is how many times  $\frac{1}{8}$  of 24?
8.  $\frac{5}{8}$  of 72 is how many times  $\frac{3}{4}$  of 20?

What is the relation,—

9. Of the unit  $\frac{1}{4}$  to the unit  $\frac{1}{8}$ ?

*Answer.— The unit  $\frac{1}{4}$  is one half of the unit  $\frac{1}{8}$ .*

10. Of the unit  $\frac{1}{8}$  to the unit  $\frac{1}{2}$ ?
11. Of the unit  $\frac{1}{12}$  to the unit  $\frac{1}{3}$ ?
12. Of the unit  $\frac{1}{10}$  to the unit  $\frac{1}{2}$ ?
13. Of the unit  $\frac{1}{8}$  to the unit  $\frac{1}{4}$ ?
14. Of the unit  $\frac{1}{8}$  to the unit  $\frac{1}{6}$ ?
15. Of the unit  $\frac{1}{2}$  to the unit  $\frac{1}{10}$ ?
16. Of the unit  $\frac{1}{3}$  to the unit  $\frac{1}{2}$ ?
17. Of the unit  $\frac{1}{5}$  to the unit  $\frac{1}{4}$ ?

Analyze,—

18.  $\frac{12}{15} = \frac{4}{5}$ . 19.  $\frac{12}{24} = \frac{1}{2} = \frac{3}{6}$ . 20.  $\frac{40}{8} = 5 = \frac{10}{2} = \frac{20}{4}$ .  
 21.  $\frac{25}{30} = \frac{5}{6}$ . 22.  $\frac{32}{40} = \frac{4}{5} = \frac{8}{10}$ . 23.  $\frac{16}{32} = \frac{1}{2} = \frac{3}{6} = \frac{4}{8}$ .  
 24.  $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{5}{10} = \frac{6}{12} = \frac{7}{14} = \frac{8}{16} = \frac{9}{18}$ .  
 25.  $\frac{1}{3} = \frac{2}{6} = \frac{3}{9} = \frac{4}{12} = \frac{5}{15} = \frac{6}{18} = \frac{7}{21}$ .

How many ones,—

26. In  $\frac{30}{6}$ ? 27. In  $\frac{28}{7}$ ? 28.  $\frac{48}{8}$ ? 29. In  $\frac{40}{4}$ ?  
 30. In  $\frac{25}{5}$ ? 31. In  $\frac{36}{9}$ ? 32. In  $\frac{27}{3}$ ? 33. In  $\frac{18}{6}$ ?  
 34.  $5\frac{2}{3} = \frac{16}{3}$ . 35.  $4\frac{9}{10} = \frac{49}{10}$ . 36.  $12\frac{2}{3} = \frac{38}{3}$ . 37.  $15\frac{1}{5} = \frac{76}{5}$ .

Reduce to least common denominator,—

38.  $\frac{2}{3}, \frac{1}{6}, \frac{5}{12}$ . 39.  $\frac{4}{5}, \frac{3}{10}, \frac{1}{4}$ . 40.  $\frac{2}{3}, \frac{5}{6}, \frac{1}{4}$ .

SUGGESTION.—Find by inspection the least number that the denominators in each example will exactly divide.

## LESSON XXX.

### ADDITION OF FRACTIONS.

1. What is the sum of  $\frac{4}{5}$  of an apple and  $\frac{3}{5}$  of an apple?

ANALYSIS.—4 of the unit  $\frac{1}{5}$  and 3 of the unit  $\frac{1}{5}$  are 7 of the unit  $\frac{1}{5} = \frac{7}{5}$ , or  $1\frac{2}{5}$  apples.

What is the sum,—

2. Of  $\frac{2}{3}$  of a day,  $\frac{1}{3}$  of a day, and  $\frac{1}{3}$  of a day?  
 3. Of  $\frac{2}{10}$  of a mile,  $\frac{3}{10}$  of a mile, and  $\frac{5}{10}$  of a mile?  
 4. Of  $\frac{4}{7}$  of a week,  $\frac{1}{7}$  of a week, and  $\frac{2}{7}$  of a week?  
 5. Of  $\frac{2}{3}, \frac{3}{4}$ , and  $\frac{5}{6}$ ?

ANALYSIS.—2 of the unit  $\frac{1}{3}$  equals 4 of the unit  $\frac{1}{6}$ , or  $\frac{4}{6}$ ; 3 of the unit  $\frac{1}{4}$  equals 9 of the unit  $\frac{1}{12}$ , or  $\frac{9}{12}$ ; 5 of the unit  $\frac{1}{6}$  equals 10 of the unit  $\frac{1}{12}$ , or  $\frac{10}{12}$ ;  $\frac{4}{6}$  and  $\frac{9}{12}$  and  $\frac{10}{12}$  are  $\frac{17}{6}$ , or  $2\frac{5}{6}$ .

6. Add  $\frac{4}{5}$ ,  $\frac{3}{10}$ , and  $\frac{1}{2}$ .

OPERATION. —  $\frac{4}{5} = \frac{8}{10}$ ,  $\frac{1}{2} = \frac{5}{10}$ ,  $\frac{8}{10} + \frac{3}{10} + \frac{5}{10} = \frac{16}{10}$ , or  $1\frac{6}{10}$ .

- |   |   |
|---|---|
| 7. Add $\frac{3}{4}$ and $\frac{1}{5}$ .                      | 12. Add $\frac{3}{7}$ and $\frac{5}{14}$ .                    |
| 8. Add $\frac{5}{8}$ and $\frac{2}{3}$ .                      | 13. Add $\frac{3}{5}$ and $\frac{7}{10}$ .                    |
| 9. Add $\frac{3}{4}$ , $\frac{7}{8}$ , and $\frac{1}{2}$ .    | 14. Add $\frac{2}{3}$ , $\frac{5}{6}$ , and $1\frac{1}{2}$ .  |
| 10. Add $\frac{5}{6}$ , $\frac{3}{4}$ , and $\frac{5}{24}$ .  | 15. Add $\frac{2}{3}$ , $\frac{7}{15}$ , and $\frac{5}{12}$ . |
| 11. Add $\frac{3}{20}$ , $\frac{9}{10}$ , and $\frac{2}{5}$ . | 16. Add $\frac{4}{5}$ , $\frac{3}{8}$ , and $\frac{3}{20}$ .  |

17. Susan gave  $\frac{7}{10}$  of a dollar for a history,  $\frac{3}{5}$  of a dollar for an arithmetic, and  $\frac{3}{4}$  of a dollar for a music book; what did she give for all?

18. John has  $\frac{4}{5}$  of a dollar, James has  $\frac{9}{10}$  of a dollar, and William has  $\frac{1}{2}$  of a dollar; how many dollars have they together.

19. A man, having  $2\frac{3}{4}$  barrels of flour, bought  $\frac{5}{8}$  of a barrel more; how much flour had he then?

20. What part of an acre is  $\frac{3}{5}$  of an acre +  $\frac{1}{8}$  of an acre?

## LESSON XXXI.

### SUBTRACTION OF FRACTIONS.

- From  $\frac{3}{4}$  of a dollar subtract  $\frac{1}{5}$  of a dollar.
- From  $\frac{7}{8}$  of a mile subtract  $\frac{3}{8}$  of a mile.
- From  $\frac{5}{6}$  of a day subtract  $\frac{1}{2}$  of a day.

OPERATION. —  $\frac{1}{2}$  equals  $\frac{3}{6}$ ,  $\frac{5}{6}$  less  $\frac{3}{6}$  equal  $\frac{2}{6}$ , or  $\frac{1}{3}$  of a day.

What is the difference, —

- |  |  |
|--|--|
| 4. Between $\frac{7}{8}$ and $\frac{5}{8}$ ?   | 8. Between $\frac{3}{8}$ and $\frac{3}{7}$ ?   |
| 5. Between $1\frac{1}{2}$ and $\frac{1}{2}$ ?  | 9. Between $\frac{5}{8}$ and $\frac{2}{3}$ ?   |
| 6. Between $\frac{9}{10}$ and $\frac{2}{3}$ ?  | 10. Between $\frac{8}{15}$ and $\frac{1}{3}$ ? |
| 7. Between $\frac{8}{15}$ and $\frac{3}{10}$ ? | 11. Between $\frac{2}{5}$ and $\frac{7}{10}$ ? |

From,—

12.  $\frac{8}{9}$  subtract  $\frac{5}{8}$ .  
 13.  $\frac{4}{5}$  subtract  $\frac{2}{3}$ .  
 14.  $\frac{3}{4}$  subtract  $\frac{1}{10}$ .  
 15.  $\frac{5}{12}$  subtract  $\frac{2}{5}$ .

20. From  $8\frac{4}{5}$  subtract  $3\frac{7}{10}$ .

From,—

16.  $\frac{11}{16}$  subtract  $\frac{3}{8}$ .  
 17.  $\frac{9}{14}$  subtract  $\frac{2}{7}$ .  
 18.  $\frac{8}{15}$  subtract  $\frac{8}{10}$ .  
 19.  $\frac{19}{28}$  subtract  $\frac{5}{11}$ .

OPERATION.— $8\frac{4}{5}=8\frac{8}{10}$ ;  $8\frac{8}{10}-3\frac{7}{10}=5\frac{1}{10}$ .21. From  $6\frac{5}{12}$  subtract  $3\frac{2}{3}$ . 25. From  $8\frac{1}{2}$  subtract  $3\frac{3}{8}$ .22. From  $9\frac{1}{8}$  subtract  $2\frac{3}{4}$ . 26. From  $7\frac{1}{4}$  subtract  $4\frac{7}{10}$ .23. From  $12\frac{9}{10}$  subtract  $5\frac{2}{5}$ . 27. From  $9\frac{3}{8}$  subtract  $3\frac{1}{4}$ .24. From  $10\frac{3}{4}$  subtract  $7\frac{1}{2}$ . 28. From  $12\frac{1}{8}$  subtract  $8\frac{7}{12}$ .

29. Charles earned  $\$8\frac{3}{4}$  a week, and paid  $\$3\frac{1}{2}$  a week for his board; how much of his week's wages remained after paying his board?

## LESSON XXXII.

### ADDITION AND SUBTRACTION.

1. Henry spent  $\frac{2}{5}$  of his money for a book and  $\frac{1}{4}$  of it for a ball; what fraction of his money remained?

2. What fraction of a number will remain after subtracting  $\frac{1}{2}$  of the number and  $\frac{1}{8}$  of it?

3. A wood dealer bought  $\frac{5}{8}$  of a cord of wood of one man and  $\frac{3}{4}$  of a cord of another; how much of this wood will remain after selling  $\frac{1}{2}$  of a cord?

4. If I pay  $\$3\frac{1}{4}$  for a hat and  $\$4\frac{1}{2}$  for a pair of shoes, how much change should I receive in paying for the goods with a 10-dollar bill?

5. Samuel owed for books  $\$4\frac{3}{4}$ . He paid at one time  $\$2\frac{1}{2}$  and at another time  $\$1\frac{1}{5}$ ; how much then remained unpaid?

6. A boy had  $8\frac{1}{2}$  miles to walk in 3 hours. If he walks 3 miles the first hour and  $2\frac{3}{4}$  miles the second hour, how far will he have to walk the third hour?

7. In an orchard  $\frac{1}{2}$  of the trees bear apples,  $\frac{1}{3}$  bear peaches, and the remainder bear pears; what part bear pears?

8. William picked  $\frac{7}{8}$  of a bushel of berries from one row, and  $\frac{9}{16}$  of a bushel from another row. His mother used  $\frac{3}{4}$  of a bushel for canning and sold the rest; how many were sold?

9.  $\frac{2}{3}$  and  $\frac{3}{4}$  less  $\frac{5}{12}$  are how many?

10.  $\frac{4}{5} - \frac{3}{4} + \frac{1}{2}$  are how many?

11.  $\frac{9}{10} + \frac{2}{5} - \frac{1}{10} =$  what?

12.  $\frac{7}{8} - \frac{1}{4} - \frac{1}{2} =$  what?

13. Two men and a boy working together did a piece of work in a day. One of the men did  $\frac{1}{3}$  of the work and the other  $\frac{2}{5}$  of it; what fraction of the work did the boy do?

14. A pile stood  $\frac{3}{10}$  of it in the mud,  $\frac{1}{5}$  of it in the water, and the rest of it in the air; how much of it was in the air?

15. What fraction must be added to the difference between  $\frac{8}{15}$  and  $\frac{2}{3}$  that the sum may be  $\frac{5}{6}$ ?

16. What fraction must be subtracted from the sum of  $\frac{7}{8}$  and  $\frac{5}{12}$  that the remainder may be  $\frac{3}{4}$ ?

17. Bought a hat for  $\$3\frac{3}{10}$  and gave in payment a 5-dollar bill; how much change should I receive?

18. How many apples are there in  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{2}{3}$ , and  $\frac{7}{12}$  of an apple?

19. From a piece of cloth,  $\frac{1}{3}$  and  $\frac{3}{8}$  of it were cut off; what part remained?

20. The sum of two fractions is  $1\frac{1}{2}$  and one of the fractions is  $\frac{2}{3}$ ; what is the other fraction?

21. Bought a crock of butter, the crock with the butter weighing  $12\frac{7}{8}$  pounds, and the crock alone weighing  $3\frac{1}{2}$  pounds; how many pounds of butter were there?



## LESSON XXXIII.

## MULTIPLICATION OF FRACTIONS.

## 1. A Fraction by an Integer.—

1. Multiply  $\frac{5}{7}$  by 3.

ANALYSIS.— $\frac{5}{7}$  is 5 of the unit  $\frac{1}{7}$ ; and 5 of the unit  $\frac{1}{7}$  multiplied by 3 is 15 of the unit  $\frac{1}{7}$ , or  $\frac{15}{7}=2\frac{1}{7}$ .

NOTE.—To multiply  $\frac{5}{7}$  by 3 is equivalent to taking  $\frac{5}{7}$  additively three times, thus  $\frac{5}{7} + \frac{5}{7} + \frac{5}{7} = \frac{15}{7}$ , or  $2\frac{1}{7}$ .

2. Multiply  $\frac{3}{5}$  by 4.

7. Multiply  $\frac{4}{5}$  by 8.

3. Multiply  $\frac{7}{8}$  by 5.

8. Multiply  $\frac{9}{11}$  by 6.

4. Multiply  $\frac{5}{9}$  by 10.

9. Multiply  $\frac{6}{8}$  by 7.

5. Multiply  $\frac{3}{14}$  by 5.

10. Multiply  $\frac{7}{12}$  by 11.

6. Multiply  $\frac{9}{10}$  by 9.

11. Multiply  $\frac{8}{5}$  by 4.

12. What will 5 bushels of wheat cost at  $\frac{3}{4}$  of a dollar a bushel?

13. What is the united length of 4 pieces of cloth, each  $\frac{3}{4}$  of a yard long?

14. How much will 7 books cost at  $\frac{5}{8}$  of a dollar each?

15. How many acres of corn can a man hoe in 4 days, at the rate of  $\frac{3}{4}$  of an acre a day?

16. If a man can cut  $\frac{7}{8}$  of a cord of wood in an hour, how much can he cut in 9 hours?

17. If  $\frac{3}{4}$  of a yard of cloth cost one dollar, how many yards can be bought for \$16?

18. If Henry can earn  $\frac{4}{5}$  of a dollar a day, how much can he earn in 8 days?

19. If a horse eat  $\frac{2}{3}$  of a bushel of oats in one day, how much will he eat in 12 days?

20. How much will I have to pay for 15 bushels of corn at  $\frac{3}{8}$  of a dollar a bushel?

21. What will 4 tons of hay cost at  $\$7\frac{3}{8}$  a ton?

22. How many miles can a man walk in 5 hours at the rate of  $3\frac{1}{2}$  miles an hour?

23. What is the weight of 7 pieces of iron each weighing  $4\frac{5}{16}$  pounds?

24. Multiply  $3\frac{5}{8}$  by 5.

25. Multiply  $10\frac{1}{2}$  by 3.

26. Multiply  $\frac{5}{12}$  by 6.

ANALYSIS.— $\frac{5}{12}$  is 5 of the unit  $\frac{1}{12}$ . If we multiply the unit  $\frac{1}{12}$  by 6, the product is the unit  $\frac{1}{2}$ . Hence,  $\frac{5}{12} \times 6 = \frac{5}{2}$ , or  $2\frac{1}{2}$ .

**Principle:—**

A number may be multiplied in two ways: 1. By multiplying the number itself. Thus, 3 pecks  $\times 3 = 9$  pecks.  
2. By multiplying the unit of the number. Thus, 3 pecks  $\times 4 = 3$  bushels.

27. Multiply  $\frac{3}{8}$  by 2.

32. Multiply  $\frac{3}{4}$  by 15.

28. Multiply  $\frac{5}{8}$  by 3.

33. Multiply  $\frac{1}{2}$  by 14.

29. Multiply  $\frac{1}{10}$  by 5.

34. Multiply  $\frac{1}{3}$  by 13.

30. Multiply  $\frac{3}{8}$  by 6.

35. Multiply  $\frac{1}{4}$  by 8.

31. Multiply  $\frac{7}{4}$  by 8.

36. Multiply  $\frac{3}{8}$  by 9.

37. Multiply 7 feet by 3.

*Result,* 7 yards.

38. Multiply 11 inches by 12.

*Result,* 11 feet.

39. Multiply 13 hours by 24.

*Result,* 13 days.

40. Multiply 25 seconds by 60.

41. If a man travel  $7\frac{3}{4}$  miles in an hour, how far will he travel in 4 hours?

42. How much will 5 tons of hay cost at  $\$8\frac{3}{4}$  a ton?

43. If a man cut  $6\frac{3}{16}$  cords of wood in a week, how many cords can he cut in 4 weeks?

44. What will 5 days' labor cost at  $\$3\frac{7}{8}$  a day.  
 45. If a farmer can harvest  $8\frac{5}{16}$  acres of wheat in a day, how many acres can he harvest in 8 days?

46. Multiply  $5\frac{1}{8}$  by 4.                      49. Multiply  $6\frac{3}{4}$  by 2.  
 47. Multiply  $7\frac{3}{8}$  by 3.                      50. Multiply  $4\frac{1}{10}$  by 10.  
 48. Multiply  $8\frac{4}{8}$  by 5.                      51. Multiply  $3\frac{1}{8}$  by 5.

52. Multiply  $\frac{5}{12}$  by 8.

ANALYSIS.—8 times  $\frac{1}{12}$  is 2 times 4 times  $\frac{1}{12} = 2$  times  $\frac{1}{3} = \frac{1}{3}$ , or  $3\frac{1}{3}$ .

NOTE.—The first step is to multiply  $\frac{1}{12}$  by 4 by multiplying its unit  $\frac{1}{12}$ , whence  $\frac{1}{3}$ , and the second step is to multiply  $\frac{1}{3}$  by 2 by multiplying the number 5, whence  $\frac{1}{3}$ .

53. Multiply  $\frac{4}{15}$  by 6.                      58. Multiply  $\frac{5}{18}$  by 12.  
 54. Multiply  $\frac{3}{20}$  by 8.                      59. Multiply  $\frac{7}{8}$  by 18.  
 55. Multiply  $\frac{5}{8}$  by 6.                      60. Multiply  $\frac{5}{8}$  by 24.  
 56. Multiply  $\frac{7}{10}$  by 4.                      61. Multiply  $\frac{4}{7}$  by 21.  
 57. Multiply  $\frac{11}{12}$  by 9.                      62. Multiply  $\frac{3}{8}$  by 20.
63. What cost 8 books at  $\frac{3}{4}$  of a dollar each?  
 64. What cost 20 pounds of butter at  $\$ \frac{3}{10}$  a pound?  
 65. What cost 15 yards of cloth at  $\$ \frac{3}{4}$  a yard?  
 66. What cost 40 bushels of potatoes at  $\$ \frac{7}{10}$  a bushel?  
 67. If a horse eat  $5\frac{1}{8}$  bushels of oats in a month, how many bushels will be required to last 6 months?  
 68. If a clock lose  $2\frac{1}{2}$  minutes a day, how many minutes will it lose in 10 days?  
 69. What will the rent of a house cost for 8 weeks at  $\$2\frac{1}{4}$  a week?  
 70. A room requires 6 breadths of carpet  $3\frac{3}{8}$  yards long; how many yards will it take to cover the floor?  
 71. What will 12 tons of hay cost at  $\$7\frac{1}{8}$  a ton?

## LESSON XXXIV.

## 2. An Integer by a Fraction.—

1. What will  $\frac{3}{4}$  of a pound of butter cost at 20 cents a pound?

ANALYSIS.—At 20 cents a pound  $\frac{1}{4}$  of a pound of butter will cost  $\frac{1}{4}$  of 20 cents, or 5 cents, and  $\frac{3}{4}$  of a pound will cost 3 times 5 cents, or 15 cents.

2. If a man can walk 40 miles in a day, how far at that rate can he walk in  $\frac{7}{8}$  of a day?

3. If a bushel of potatoes cost 60 cents, what will  $\frac{3}{4}$  of a bushel cost?

4. What will  $\frac{5}{8}$  of a ton of hay cost at \$16 a ton?

5. I buy a horse for \$90 and sell it for  $\frac{4}{5}$  of the cost; how many dollars do I receive for the horse?

6. Multiply 24 by  $\frac{5}{12}$ .

NOTE.—To multiply 24 by  $\frac{5}{12}$  is to find  $\frac{5}{12}$  of 24.

Multiply,—

7. 50 by  $\frac{3}{10}$ .

10. 30 by  $\frac{4}{15}$ .

13. 12 by  $2\frac{1}{2}$ .

8. 42 by  $\frac{5}{14}$ .

11. 39 by  $\frac{6}{13}$ .

14. 15 by  $3\frac{1}{3}$ .

9. 48 by  $\frac{7}{12}$ .

12. 45 by  $\frac{8}{9}$ .

15. 18 by  $2\frac{5}{6}$ .

16. What is  $\frac{1}{3}$  of 8?

(a.) ANALYSIS.— $\frac{1}{3}$  of 8 is one of the 3 equal parts of 8 which is  $\frac{8}{3}$ , or  $2\frac{2}{3}$ .

(b.) ANALYSIS.— $\frac{1}{3}$  of 8 =  $\frac{1}{3}$  of  $2\frac{2}{3}$  =  $\frac{8}{9}$ , or  $2\frac{2}{3}$ .

(c.) ANALYSIS.— $\frac{1}{3}$  is  $\frac{1}{3}$  of 1,  $\frac{1}{3}$  of 8 is 8 times  $\frac{1}{3}$  of 1, or  $\frac{8}{3}$  =  $2\frac{2}{3}$ .

17. What is  $\frac{1}{4}$  of 9?

21. What is  $\frac{1}{7}$  of 20?

18. What is  $\frac{1}{5}$  of 12?

22. What is  $\frac{1}{8}$  of 25?

19. What is  $\frac{1}{6}$  of 19?

23. What is  $\frac{1}{9}$  of 38?

20. What is  $\frac{2}{3}$  of 8?

24. What is  $\frac{3}{5}$  of 12?

## LESSON XXXV.

## 3. A Fraction by a Fraction.—

1. If a man can chop  $\frac{1}{8}$  of a cord of wood in 1 day, how much can he chop in  $\frac{3}{8}$  of a day?

ANALYSIS.—In  $\frac{1}{8}$  of a day, he could chop  $\frac{1}{8}$  of  $\frac{1}{8}$  of a cord, or  $\frac{1}{64}$  of a cord, and in  $\frac{3}{8}$  of a day he could chop 3 times  $\frac{1}{64}$  of a cord, or  $\frac{3}{64}$  of a cord.

2. What will  $\frac{3}{8}$  of a pound of tea cost at  $\frac{3}{8}$  of a dollar a pound?

3. What is  $\frac{3}{4}$  of  $\frac{3}{11}$ ?

7. What is  $\frac{3}{8}$  of  $\frac{3}{18}$ ?

4. What is  $\frac{4}{5}$  of  $\frac{1}{7}$ ?

8. What is  $\frac{3}{8}$  of  $\frac{1}{8}$ ?

5. What is  $\frac{5}{6}$  of  $\frac{1}{8}$ ?

9. What is  $\frac{4}{7}$  of  $\frac{7}{8}$ ?

6. What is  $\frac{4}{5}$  of  $\frac{1}{2}$ ?

10. What is  $\frac{5}{6}$  of  $\frac{1}{2}$ ?

ANALYSIS.— $\frac{1}{8}$  of  $\frac{1}{8}$  is  $\frac{1}{64}$  and  $\frac{3}{8}$  of  $\frac{1}{8}$  is 4 times  $\frac{1}{64}$ , or  $\frac{3}{64}$ .

11. What is  $\frac{3}{8}$  of  $\frac{3}{4}$ ?

14. What is  $\frac{5}{7}$  of  $\frac{1}{8}$ ?

12. What is  $\frac{3}{4}$  of  $\frac{8}{9}$ ?

15. What is  $\frac{7}{8}$  of  $\frac{1}{2}$ ?

13. What is  $\frac{4}{5}$  of  $\frac{1}{6}$ ?

16. What is  $\frac{8}{9}$  of  $\frac{2}{7}$ ?

17. What is  $\frac{5}{6}$  of  $\frac{3}{10}$ ?

ANALYSIS.— $\frac{1}{8}$  of  $\frac{1}{8}$  is  $\frac{1}{64}$  of  $\frac{1}{8}$ , or  $\frac{1}{512}$ ; and  $\frac{3}{8}$  of  $\frac{1}{8}$  is 4 times  $\frac{1}{512}$ , or  $\frac{3}{512}$ .

18. What is  $\frac{3}{4}$  of  $\frac{2}{5}$ ?

20. What is  $\frac{4}{15}$  of  $\frac{5}{18}$ ?

19. What is  $\frac{5}{12}$  of  $\frac{8}{15}$ ?

21. What is  $\frac{5}{18}$  of  $\frac{6}{25}$ ?

22. Multiply  $\frac{4}{5}$  by  $\frac{3}{8}$ .

ANALYSIS.—To multiply  $\frac{4}{5}$  by  $\frac{3}{8}$  is to find  $\frac{3}{8}$  of  $\frac{4}{5}$ ;  $\frac{1}{8}$  of  $\frac{4}{5}$  is  $\frac{1}{10}$ , and  $\frac{3}{8}$  of  $\frac{4}{5}$  is 2 times  $\frac{1}{10}$ , or  $\frac{3}{10}$ .

23. Multiply  $\frac{5}{6}$  by  $\frac{5}{8}$ .

25. Multiply  $\frac{7}{12}$  by  $\frac{5}{8}$ .

24. Multiply  $\frac{4}{5}$  by  $\frac{3}{8}$ .

26. Multiply  $\frac{1}{18}$  by  $\frac{5}{8}$ .

27. If a bushel of wheat is worth  $\frac{1}{8}$  of a dollar, what would be the worth of  $\frac{5}{8}$  of a bushel?

## LESSON XXXVI.

## DIVISION OF FRACTIONS.

## 1. A Fraction by an Integer.—

1. Divide
- $\frac{3}{4}$
- by 2.

ANALYSIS.— $\frac{3}{4}$  is 6 of the unit  $\frac{1}{4}$ . To divide  $\frac{3}{4}$  by 2 is to find  $\frac{1}{2}$  of  $\frac{3}{4}$ ;  $\frac{1}{2}$  of 6 of the unit  $\frac{1}{4}$  is 3 of the unit  $\frac{1}{4}$ , or  $\frac{3}{8}$ .

2. Divide
- $\frac{3}{8}$
- by 4.

5. Divide
- $\frac{1}{2}$
- by 4; by 8.

3. Divide
- $\frac{9}{10}$
- by 3.

6. Divide
- $\frac{1}{8}$
- by 3; by 5.

4. Divide
- $\frac{1}{2}$
- by 6.

7. Divide
- $\frac{1}{2}$
- by 6; by 9.

8. If  $\frac{2}{3}$  of a dollar be equally divided among 3 boys, what part of a dollar will each receive?

9. What is one of the 4 equal parts into which  $5\frac{1}{2}$  feet may be divided?

10. Divide
- $8\frac{1}{2}$
- bushels by 7.

11. Divide
- $9\frac{1}{2}$
- acres by 12.

12. At what price per day can a man earn  $10\frac{1}{2}$  dollars in 6 days?

13. At what rate per hour can a man walk  $17\frac{1}{2}$  miles in 5 hours?

14. If 7 yards of cloth cost  $5\frac{1}{2}$  dollars, what is the cost per yard?

15. At \$2 a day, what part of a day can a man work for  $\frac{1}{2}$ .

Answer.—Such a part of a day as denotes the number of times that \$2 is contained in  $\frac{1}{2}$ , or  $\frac{1}{4}$  of a day.

16. If I rent land for the season at \$5 an acre, how many acres can I rent for  $\$12\frac{1}{2}$ ?

17. At the rate of 4 miles an hour, how long will it take to walk  $25\frac{1}{2}$  miles?

18. How many steps of 2 feet each will one take in walking  $11\frac{1}{2}$  feet?

19. How many cords of wood at \$3 a cord may be bought for \$25 $\frac{1}{2}$ ?

20. At 6 miles an hour how long will a carriage be going 8 $\frac{3}{4}$  miles?

21. What is  $8\frac{3}{4} \div 4$ ?

23. What is  $15\frac{5}{8} \div 5$ ?

22. What is  $12\frac{3}{8} \div 3$ ?

24. What is  $18\frac{1}{2} \div 6$ ?

25. Divide  $\frac{3}{5}$  by 4.

(a.) ANALYSIS.— $\frac{3}{5}$  equals  $\frac{1}{5}$ ; and  $\frac{1}{5}$  of  $\frac{1}{5}$  is  $\frac{1}{25}$ .

(b.) ANALYSIS.— $\frac{3}{5}$  is 3 of the unit  $\frac{1}{5}$ ;  $\frac{1}{4}$  of the unit  $\frac{1}{5}$  is the unit  $\frac{1}{20}$ . Hence, 3 of the unit  $\frac{1}{20}$  or  $\frac{3}{20}$  is  $\frac{1}{4}$  of  $\frac{3}{5}$ .

**Principle:—**

A number may be divided in two ways: 1. By dividing the number itself. Thus, 6 yards  $\div 3 = 2$  yards; or 2. By dividing the unit of the number. Thus, 2 yards  $\div 3 = 2$  feet.

26. Divide  $\frac{2}{3}$  by 3.

28. Divide  $\frac{3}{10}$  by 4.

27. Divide  $\frac{1}{3}$  by 5.

29. Divide  $\frac{5}{8}$  by 7.

30. Divide 5 weeks by 7.

*Result, 5 days.*

31. Divide 7 hours by 60.

*Result, 7 minutes.*

32. Divide  $\frac{1}{2}$  by 6.

ANALYSIS.— $\frac{1}{2}$  of  $\frac{1}{2}$  is  $\frac{1}{4}$  of  $\frac{1}{2}$  of  $\frac{1}{2} = \frac{1}{8}$  of  $\frac{1}{2} = \frac{1}{16}$ .

33. Divide  $\frac{5}{8}$  by 6.

36. Divide  $8\frac{1}{2}$  by 14.

34. Divide  $\frac{3}{4}$  by 4.

37. Divide  $5\frac{3}{4}$  by 12.

35. Divide  $\frac{1}{11}$  by 8.

38. Divide  $6\frac{3}{8}$  by 15.

39. At what rate per hour can a man walk  $19\frac{1}{2}$  miles in 6 hours?

40. At \$8 a ton, how many tons of hay can be bought for \$16 $\frac{1}{2}$ ?

41. James sold 8 quarts of berries for  $\$4\frac{1}{2}$ ; how much did he receive per quart for them?

42. Henry divided  $\frac{1}{6}$  of a melon equally among 6 boys; what part of a melon did each boy receive?

43. At 4 miles an hour how long will it take to walk  $25\frac{1}{2}$  miles?

44. How long will it take to earn  $\$22\frac{1}{2}$  at the rate of  $\$3$  a day?

45. If 7 barrels of apples cost  $\$19\frac{3}{4}$ , what does 1 barrel cost?

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## LESSON XXXVII.

### 2. An Integer by a Fraction.—

1. How many times is  $\frac{3}{4}$  contained in 6?

ANALYSIS.— $6 = 2\frac{2}{4}$ , in which  $\frac{3}{4}$  is contained 8 times.

2. How many times is  $\frac{3}{8}$  contained in 4? in 6? in 8?

3. How many times is  $\frac{1}{4}$  contained in 8? in 12? in 20?

4. At  $\$5\frac{1}{2}$  a bushel, how many bushels of wheat can be bought for  $\$15$ ?

SUGGESTION.—Think first how many bushels could be bought for  $\$15$  at  $\$5$  a bushel; and then think how that number of bushels would be changed if the price were changed from  $\$5$  to  $\frac{1}{2}$  of  $\$5$ , or  $\$2\frac{1}{2}$  a bushel.

5. How many pounds of tea at  $\$4\frac{1}{2}$  a pound can be bought for  $\$12$ ?

6. How many times is  $\frac{1}{6}$  of an acre contained in 6 acres?

ANALYSIS.— $\frac{1}{6}$  of an acre is contained in 6 acres 48 times, and  $\frac{1}{6}$  of an acre is contained in 6 acres  $\frac{1}{6}$  of 48 times, or  $9\frac{1}{2}$  times.

7. How many days will it take to cut 9 cords of wood at the rate of  $\frac{1}{3}$  of a cord a day?



8. At  $\frac{2}{3}$  of a dollar a gallon, how many gallons of syrup can be bought for \$5?

9. How many hours will it take to pick 12 quarts of berries if  $2\frac{1}{2}$  quarts can be picked in 1 hour?

10. How many sheep can be bought for \$38, at  $\$3\frac{1}{2}$  a head?

Divide,—

11. 16 by  $\frac{1}{4}$ .

14. 35 by  $\frac{7}{10}$ .

17. 10 by  $1\frac{1}{4}$ .

12. 24 by  $\frac{3}{8}$ .

15. 36 by  $\frac{4}{5}$ .

18. 8 by  $2\frac{3}{4}$ .

13. 30 by  $\frac{2}{3}$ .

16. 27 by  $\frac{9}{11}$ .

19. 22 by  $2\frac{3}{4}$ .

20. At  $\frac{2}{3}$  of a dollar a bushel, how many bushels of potatoes can be bought for 10 dollars?

21. How much cloth at  $1\frac{1}{2}$  dollars a yard can be bought for 5 dollars?

22. At 4 dollars a bushel what quantity of cranberries may be bought for  $\frac{7}{8}$  of a dollar?

23. If a carpenter can build  $4\frac{1}{2}$  rods of picket fence in one day, in how many days can he build 33 rods?

24. In how many days at the rate of  $2\frac{1}{4}$  dollars a day can a man earn 12 dollars?

25. A teamster feeds his horses  $\frac{3}{4}$  of a bushel of oats a day; how long will 10 bushels last?

## LESSON XXXVIII.

### 3. A Fraction by a Fraction.—

1. How many times is  $\frac{2}{3}$  contained in  $\frac{4}{5}$ ?

ANALYSIS.—3 is contained in  $\frac{4}{5}$   $\frac{3}{5}$  times; hence,  $\frac{2}{3}$  of 3 or  $\frac{2}{3}$  is contained in  $\frac{4}{5}$  5 times  $\frac{2}{3}$  times, or  $1\frac{2}{3}$  times.

2. How many times is  $\frac{2}{3}$  contained in  $\frac{4}{5}$ ?

3. How many times is  $\frac{2}{3}$  contained in  $1\frac{2}{3}$ ?

4. How many times is  $\frac{2}{3}$  contained in  $\frac{3}{4}$ ?

5. How many times is  $\frac{3}{4}$  contained in  $\frac{5}{8}$ ?

ANALYSIS.—3 is contained in  $\frac{3}{4}$   $\frac{4}{1}$  times; hence,  $\frac{1}{4}$  of 3 or  $\frac{3}{4}$  is contained in  $\frac{3}{4}$  7 times  $\frac{4}{1}$  times, or  $\frac{28}{4}$  times, or  $1\frac{1}{4}$ .

6. How many times is  $\frac{3}{4}$  contained in  $4\frac{1}{2}$ ?

7. How many times is  $\frac{3}{4}$  contained in  $5\frac{3}{4}$ ?

8. Divide  $\frac{1}{2}$  by  $2\frac{1}{2}$ .

9. Divide  $2\frac{3}{4}$  by  $\frac{3}{4}$ .

10. If a man can do  $\frac{2}{3}$  of a piece of work in 1 day, how many days will it take him to do  $\frac{1}{2}$  of the work?

ANALYSIS.—It will take as many days as  $\frac{3}{2}$ , or  $\frac{1}{1\frac{1}{2}}$ , is contained times in  $\frac{1}{2}$ , or  $\frac{1}{1\frac{1}{2}}$ , which is  $4\frac{1}{2}$  days.

11. If a pound of coffee cost  $\frac{3}{4}$  of a dollar, how many pounds can be bought for \$4 $\frac{1}{2}$ ?

12. If  $\frac{2}{3}$  of a bushel of wheat cost  $\frac{1}{10}$  of a dollar what will 1 bushel cost?

13. How many cords of wood can be cut in 1 day at the rate of  $5\frac{1}{2}$  cords in  $3\frac{3}{4}$  days?

14. If  $6\frac{3}{4}$  yards of cloth make a suit of clothes, how many such suits may be made from  $20\frac{1}{2}$  yards?

15. At what wages per day can a man earn \$5 $\frac{3}{4}$  in  $4\frac{3}{4}$  days?

16. If a man walk  $4\frac{3}{4}$  miles an hour, how many hours will it take him to walk  $9\frac{1}{4}$  miles?

OPERATION.— $4\frac{3}{4} = \frac{19}{4}$ ,  $9\frac{1}{4} = \frac{37}{4}$ . To divide  $\frac{37}{4}$  by  $\frac{19}{4}$ , we first divide  $\frac{37}{4}$  by 11, obtaining  $\frac{1}{11}$  which we divide by 2, obtaining  $\frac{1}{22}$ . We then multiply  $\frac{1}{22}$  by 5, obtaining  $\frac{5}{22}$ , or  $2\frac{1}{11}$ .

17. If  $3\frac{1}{2}$  tons of hay last one week, how many weeks will  $8\frac{3}{4}$  tons last?

18. At what rate of travel per hour can a man walk  $12\frac{3}{4}$  miles in  $3\frac{3}{4}$  hours?

19. At what price per bushel will  $6\frac{1}{2}$  bushels of wheat cost \$9 $\frac{3}{4}$ ?

20. At what price per ton will  $2\frac{1}{2}$  tons of hay cost \$17 $\frac{1}{2}$ ?  
 21. If a man cut  $17\frac{1}{2}$  cords of wood in  $2\frac{1}{2}$  weeks, how many cords can he cut in a week?  
 22. At \$6 $\frac{1}{2}$  a barrel, how many barrels of flour can be bought for \$20 $\frac{1}{2}$ ?  
 23.  $\frac{1}{2} \div \frac{2}{3} = ?$       24.  $\frac{1}{2} \div \frac{1}{4} = ?$       25.  $\frac{2}{3} \div \frac{1}{2} = ?$

## LESSON XXXIX.

1. Add  $\frac{1}{2}$  and  $\frac{2}{3}$  and multiply the sum by  $\frac{2}{3}$ .
  2. Add  $\frac{3}{10}$  and  $\frac{1}{5}$  and multiply the sum by  $\frac{1}{5}$ .
  3. From  $3\frac{7}{10}$  subtract  $\frac{2}{3}$  and divide the remainder by  $2\frac{1}{2}$ .
  4. From  $5\frac{2}{3}$  subtract  $1\frac{1}{2}$  and divide the remainder by 5.
  5. Multiply  $\frac{5}{6}$  by  $\frac{4}{5}$  and divide the product by  $\frac{2}{3}$ .
  6. Divide  $\frac{1}{2} \times \frac{2}{3}$  by  $\frac{2}{3}$  and multiply the quotient by  $2\frac{1}{2}$ .
  7.  $4 \div \frac{2}{3}$  is how many times  $\frac{1}{2}$ ?
  8.  $5 \div \frac{1}{2}$  is how many times  $\frac{2}{3}$ ?
  9.  $\frac{2}{3} \times \frac{2}{3}$  is contained how many times in  $\frac{2}{10}$ ?
  10.  $\frac{2}{3}$  of 20 is how many times  $\frac{2}{3}$  of 12?
  11.  $\frac{2}{3}$  of  $\frac{5}{6}$  is how many times  $\frac{5}{6}$  of  $\frac{1}{3}$ ?
  12.  $\frac{2}{3}$  of  $\frac{2}{3}$  is contained how many times in  $\frac{7}{12}$ ?
  13. If a man can do  $\frac{2}{3}$  of a piece of work in  $2\frac{1}{2}$  days, in how many days can he do the whole work?
  14. If I pay \$ $\frac{2}{10}$  for  $\frac{2}{3}$  of a bushel of wheat, what shall I pay for 1 bushel?
  15. What will a dozen oranges cost at the rate of 10 cents for  $\frac{2}{3}$  of a dozen?
  16. If 3 barrels of flour cost \$15, what will 7 barrels cost?
- (a.) ANALYSIS.—1 barrel will cost  $\frac{1}{3}$  of \$15, or \$5, and 7 barrels will cost 7 times \$5, or \$35.

(b.) ANALYSIS.—7 barrels is  $\frac{7}{3}$  of 3 barrels, and will therefore cost  $\frac{7}{3}$  of \$15, or \$35.

17. What will be the cost of 15 days' labor at the rate of \$18 for  $4\frac{1}{2}$  days?

18. How many miles can a man walk in 4 hours if he can walk 50 miles in 15 hours?

19. If it takes 5 hours to do  $\frac{3}{4}$  of a piece of work, what part of the work can be done in 14 hours?

20. If 30 barrels of flour will last a company of 8 men a certain length of time, how many barrels will last 5 men the same length of time?

21. What will 10 pounds of rice cost at  $6\frac{1}{2}$  cents a pound?

22. At  $\$1\frac{3}{10}$  a pound how many pounds of butter can be bought for \$4 $\frac{1}{2}$ ?

23. A man paid \$26 $\frac{1}{8}$  for  $4\frac{3}{4}$  tons of hay, what did he pay per ton?

24. How many weeks will 28 pounds of butter last at  $3\frac{1}{2}$  pounds per week?

25. In how many hours can a stage go  $32\frac{1}{2}$  miles at the rate of  $6\frac{1}{2}$  miles an hour?

26. If 4 apples cost  $6\frac{2}{3}$  cents, what will 6 apples cost at the same rate?

27. What will be the cost of 9 yards of cloth at the rate of  $\frac{2}{3}$  of a yard for  $\frac{3}{4}$  of a dollar?

28. Henry bought 15 peaches at the rate of  $\frac{3}{4}$  of a peach for  $\frac{1}{4}$  of a cent; what did the peaches cost him?

29. What must I pay for 3 bushels of berries if  $\frac{3}{4}$  of a bushel cost  $\frac{1}{4}$  of a dollar?

30. A walks  $3\frac{1}{4}$  miles an hour and B  $3\frac{1}{2}$  miles. How many hours will it take A to walk  $22\frac{3}{4}$  miles, and how many will it take B? If they walk toward each other from two points 54 miles apart, how long before they will meet?

## LESSON XL.

## RELATION OF NUMBERS.

When we say 6 is *one half* of 12, the fraction  $\frac{1}{2}$  expresses the relation of 6 to 12. Again, when we say 12 is *twice* 6 or *two times* 6, the number 2 expresses the relation of 12 to 6.

What is the relation, —

- |                |                |                |
|----------------|----------------|----------------|
| 1. Of 6 to 18? | 2. Of 5 to 20? | 3. Of 4 to 20? |
| 4. Of 12 to 4? | 5. Of 12 to 3? | 6. Of 15 to 3? |

The number that is compared is called the *antecedent*. Thus, in the expression \$5 is one half of \$10, the number \$5 is the antecedent.

The number with which the antecedent is compared is called the *consequent*. Thus, in the expression 8 days is four fifths of 10 days, the number 10 days is the consequent.

The number that expresses the relation of the antecedent to the consequent is called the *ratio*. Thus, in the expression 10 bushels is two thirds of 15 bushels,  $\frac{2}{3}$  is the ratio.

## 1. To Find the Antecedent. —

1. What is  $\frac{1}{5}$  of 40 cords of wood?

ANALYSIS. —  $\frac{1}{5}$  of 40 cords is 5 cords;  $\frac{1}{5}$  of 40 cords is 7 times 5 cords, or 35 cords.

NOTE. — This is the same problem under a different aspect that we have before had in two different connections: (1) as illustrative of the meaning of a fraction, Lesson XXIII; and (2) as a case in multiplication, Lesson XXXIV.

- |                                  |  |
|----------------------------------|--|
| 2. What is $\frac{5}{7}$ of 42?  | 7. Find $\frac{5}{8}$ of 24.               |
| 3. What is $\frac{4}{9}$ of 45?  | 8. Find $\frac{7}{12}$ of 60.              |
| 4. What is $\frac{3}{10}$ of 50? | 9. Find $\frac{2}{3}$ of $\frac{5}{7}$ .   |
| 5. What is $\frac{7}{11}$ of 55? | 10. Find $\frac{4}{5}$ of $3\frac{1}{2}$ . |
| 6. What is $\frac{6}{13}$ of 39? | 11. Find $\frac{5}{8}$ of $7\frac{1}{2}$ . |

**Principle:—**

The antecedent equals the consequent multiplied by the ratio.

**2. To find the Ratio.—**

12. 5 is what part of 7?

ANALYSIS.—1 is  $\frac{1}{7}$  of 7, whence, 5 is  $\frac{5}{7}$  of 7.

13. 7 is what part of 12? of 21? of 56? of 15?  
 14. 9 is what part of 13? of 30? of 39? of 45? of 51?  
 15. 10 is what part of 25? of 45? of 50?  
 16. 8 is what part of 20? of 36? of 44? of 48?  
 17.  $2\frac{1}{2}$  is what part of 15?

SUGGESTION.— $2\frac{1}{2}$  is the same part of 15 that 5 is of 30.

18.  $4\frac{3}{8}$  is what part of 7? of 10? of 6?  
 19.  $6\frac{1}{2}$  is what part of 9? of 12? of 10?  
 20.  $4\frac{1}{2}$  is what part of 8? of 6? of 9?  
 21.  $2\frac{2}{3}$  is what part of  $7\frac{1}{2}$ ? 23.  $4\frac{1}{3}$  is what part of  $5\frac{1}{2}$ ?  
 22.  $3\frac{1}{2}$  is what part of  $6\frac{1}{2}$ ? 24.  $6\frac{2}{3}$  is what part of  $16\frac{2}{3}$ ?

**Principle:—**

The ratio equals the antecedent divided by the consequent.

**3. To Find the Consequent.—**

25. 18 is  $\frac{2}{3}$  of what number?

ANALYSIS.—Since 18 is  $\frac{2}{3}$  of the required number,  $\frac{1}{3}$  of 18, or 6, is  $\frac{1}{3}$  of that number, and 5 times 6, or 30, is the required number. That is, 18 is  $\frac{2}{3}$  of 30.

26. 12 is  $\frac{4}{5}$  of what number? 35.  $\frac{3}{4}$  is  $\frac{4}{5}$  of what?  
 27. 14 is  $\frac{7}{10}$  of what number? 36.  $\frac{2}{3}$  is  $\frac{9}{10}$  of what?  
 28. 15 is  $\frac{5}{8}$  of what number? 37.  $\frac{4}{5}$  is  $\frac{8}{15}$  of what?  
 29. 20 is  $\frac{4}{5}$  of what number? 38.  $5\frac{5}{8}$  is  $\frac{7}{8}$  of what?  
 30. 27 is  $\frac{9}{13}$  of what number? 39.  $4\frac{1}{2}$  is  $\frac{3}{8}$  of what?  
 31. 30 is  $\frac{4}{5}$  of what number? 40.  $6\frac{2}{3}$  is 5 times what?  
 32. 22 is  $\frac{2}{3}$  of what number? 41.  $7\frac{1}{3}$  is 6 times what?  
 33. 15 is  $\frac{2}{3}$  of what number? 42.  $15\frac{2}{3}$  is 7 times what?  
 34. 24 is  $\frac{5}{8}$  of what number? 43.  $8\frac{2}{3}$  is 10 times what?

**Principle:** —

The consequent equals the antecedent divided by the ratio.

## LESSON XLI.

1. What number is the same part of 30 that 3 is of 5?  
that 5 is of 6?
2. What number is the same part of 42 that 2 is of 7?  
that 3 is of 14?
3. What number is the same part of 56 that 5 is of 8?  
that 4 is of 7?
4. 2 is to 5 as what number is to 15?
5. 3 is to 4 as what number is to 16?

**NOTE.**—This writing is usually abbreviated thus:  $3:4::?:16?$

- |                 |                  |
|-----------------|------------------|
| 6. $5:8::?:24?$ | 7. $3:10::?:40?$ |
| 8. $4:7::?:35?$ | 9. $7:9::?:36?$  |
| 10. $3:8::6:?$  | 11. $4:5::8:?$   |
| 12. $2:3::10:?$ | 13. $5:3::15:?$  |
| 14. $6:5::3:?$  | 15. $7:2::35:?$  |

16. What number increased by  $\frac{2}{3}$  of itself equals 10?

**SUGGESTION.**—A number increased by  $\frac{2}{3}$  of itself equals  $\frac{5}{3}$  of the number.

17. What number increased by  $\frac{1}{2}$  of itself equals 9? equals 12?

18. What number increased by  $\frac{3}{4}$  of itself equals 14? equals 35?

19. What number increased by  $\frac{5}{8}$  of itself equals 40? equals 56?

20. John, having increased his number of the marbles by  $\frac{3}{4}$  of itself, had 44 marbles; how many marbles had he before the increase?

21. A man walked 45 miles the second day of a journey, thereby increasing the distance he walked the first day by  $\frac{1}{3}$  of it; how many miles did he walk the first day?

22. A man sold a cow for \$36, thereby gaining  $\frac{1}{4}$  of her cost; what did she cost?

23. What number plus  $\frac{1}{4}$  of it equals 30?

24. What number plus  $\frac{5}{11}$  of it equals 24?

25. What number plus  $\frac{3}{7}$  of it equals 15?

26. What number is it from which if  $\frac{3}{8}$  of it be subtracted the remainder is 24?

SUGGESTION.—A number diminished by  $\frac{3}{8}$  of itself becomes  $\frac{5}{8}$  of it.

27. What number diminished by  $\frac{1}{4}$  of itself becomes 27? becomes 42?

28. What number less  $\frac{3}{4}$  of it equals 18? equals 30? equals 35?

29. What number less  $\frac{2}{3}$  of it equals 8? equals 13? equals 25?

30. What number less  $\frac{3}{4}$  of it equals  $2\frac{1}{2}$ ? equals  $3\frac{3}{4}$ ? equals  $5\frac{3}{4}$ ?

31. John, having spent  $\frac{3}{4}$  of his money, had 50 cents remaining; how many cents had he at first?

32. Mary spent  $\frac{3}{4}$  of her vacation in the country and the remaining 12 days in the city; how long was her vacation?



## LESSON XLII.

1. A room is 50 ft. long, and its width is  $\frac{4}{5}$  its length; how wide is it?
2. John has 48 marbles and James has  $\frac{5}{8}$  as many marbles as John; how many marbles has James?
3. Three fourths of the distance between two towns is 24 miles; what is the whole distance?
4. If  $\frac{3}{8}$  of a bushel of wheat costs 70 cents, what will a bushel cost?
5. A has 45 sheep and B has 63 sheep; what part of B's number is A's number? What part of A's number is B's number?
6. A man has 56 miles to travel. What part of the distance will be traveled when he has gone 40 miles?
7. If  $\frac{7}{10}$  of a piece of work can be done in 28 hours, how many hours would it take to do the entire work?
8. Two men, A and B, together cut 56 cords of wood, of which A cut 24 cords. What is the ratio (1) of the number of cords that A cut to the number that they both cut? (2) of the number of cords that B cut to the number that A cut?
9. If 65 pounds of flour will last a family a month, how many pounds will last the same family  $\frac{5}{7}$  of a month?
10. If  $\frac{3}{4}$  of a cistern full of water leak out in 15 hours, in how many hours will a whole cistern full leak out?
11. A man is 45 years old and his wife is 39 years old. What part of the husband's age is the wife's age? What fraction of the wife's age is the husband's age?
12. A merchant sold a suit of clothes for \$35, thereby gaining  $\frac{2}{5}$  of the cost of the suit. What did the suit cost?

13. A man sold a sleigh for \$25 at a loss of  $\frac{3}{8}$  of the cost. What did the sleigh cost?

14. Horace had 42 marbles. He gave  $\frac{2}{3}$  of them to his brother Henry. What then was the ratio of the number that Henry had to the number that Horace had?

15. A field is 28 rods wide and 49 rods long. What part of the length is the width? What fraction of the width is the length?

16. A father divided 25 cents between his son and daughter in such a way that the daughter's share was  $\frac{2}{3}$  of the son's. How many cents did each receive?

ANALYSIS.— Daughter's share,  $\frac{2}{3}$  son's share; daughter's and son's shares together, or 25 cents, equals  $\frac{5}{3}$  of son's share;  $\frac{1}{3}$  of son's share equals  $\frac{1}{5}$  of 25 cents, or 5 cents; and son's share equals 3 times 5 cents, or 15 cents. The daughter's share equals 25 cents less 15 cents, or 10 cents.

17. If \$35 be divided between A and B so that A's share shall be  $\frac{2}{3}$  of B's share, how many dollars will A and B each receive?

18. A man traveled 63 miles in two days, going  $\frac{2}{3}$  as many miles on the first day as on the second. How many miles did he travel each day?

19. A stick of timber 16 feet long was cut in two pieces of which one was  $\frac{3}{4}$  as long as the other. What was the length of each piece?

20. Suppose \$50 to be divided between A and B so that  $\frac{1}{2}$  of A's share shall be equal to  $\frac{1}{3}$  of B's; how many dollars will each then receive?

21. What will 5 boxes of raisins cost if  $\frac{3}{4}$  of a box cost 6 dollars?

22. If 8 apples are worth 3 oranges, how many apples are 15 oranges worth?

23. How far can a man walk in 4 days if in  $\frac{3}{8}$  of a day he can walk 20 miles?

24. If 6 men can chop 9 cords of wood in a day, how many cords can 8 men chop in the same time?

25. If  $\frac{3}{4}$  of a barrel of flour cost \$6, what will  $\frac{1}{8}$  of a barrel cost?

What is the relation,—

26. Of  $\frac{3}{8}$  to  $\frac{1}{8}$ ?

29. Of  $\frac{7}{10}$  to  $\frac{1}{8}$ ?

27. Of  $\frac{5}{8}$  to  $\frac{3}{4}$ ?

30. Of  $7\frac{1}{2}$  to 10?

28. Of  $\frac{1}{4}$  to  $\frac{3}{8}$ ?

31. Of  $2\frac{3}{4}$  to  $3\frac{3}{8}$ ?

32.  $\frac{3}{8}$  is the relation of what number to 24?

33.  $\frac{5}{8}$  is the relation of what number to 12?

34.  $2\frac{3}{8}$  is the relation of what number to 9?

35.  $\frac{3}{4}$  is the relation of 6 to what number?

36.  $\frac{1}{8}$  is the relation of 15 to what number?

37.  $2\frac{1}{2}$  is the relation of 10 to what number?

38.  $3\frac{1}{4}$  is the relation of  $8\frac{3}{8}$  to what number?

39.  $5\frac{1}{8}$  is the relation of  $10\frac{3}{8}$  to what number?

40. A man traveled  $\frac{3}{8}$  of a journey in  $4\frac{3}{8}$  days; in how many days can he finish the journey?

41. A merchant sold some cloth at 75 cents a yard, gaining  $\frac{1}{4}$  of the cost; what did the cloth cost per yard?

42. A grocer sold 10 lb. of butter for \$3 $\frac{1}{2}$ , losing  $\frac{1}{8}$  of the cost; what did the butter cost per pound?

43. An employer paid 10 men and 10 women \$17 $\frac{1}{2}$  for a day's labor. If he paid the women  $\frac{3}{4}$  as much as the men, how much did each man and each woman receive?

44. A hat cost \$2 $\frac{1}{2}$  and was sold for \$2 $\frac{9}{10}$ ; what part of the cost was the gain?

45. A has \$25 and B has  $\frac{3}{8}$  as much plus \$5; B's money is what part of A's?

46. A had \$20, and after spending  $\frac{2}{5}$  of it, he had  $\frac{1}{4}$  as much money as B; how many dollars had B?

47. A had \$35; and after he had spent  $\frac{3}{4}$  of it, and after B had spent  $\frac{2}{3}$  of his money, the two had equal sums; how many dollars had B at first?

48.  $\frac{2}{3}$  of what number equals  $\frac{3}{4}$  of 40?

49. What part of 25 equals  $\frac{3}{4}$  of 35?

50. If 3 men can do a piece of work in 12 days, in how many days can 4 men do it?

51. If  $\frac{3}{4}$  of a bushel of wheat cost  $\frac{1}{2}$  of a dollar, what will 3 bushels cost?

52. What is the relation of  $\frac{3}{10}$  of 20 to  $\frac{1}{5}$  of 18?

53. If 4 men earn \$5 in a day, and 5 women earn \$4 in the same time, what is the relation of a woman's daily wages to that of a man's?

54. If  $\frac{2}{3}$  of one number is equal to  $\frac{1}{3}$  of another number, what is the relation of the first number to the second one? of the second one to the first?

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55. A man traveled 50 miles in 2 days, going  $\frac{1}{3}$  as many miles the first day as the second; how many miles did he travel each day?

56. A grocer sold a barrel of pork for \$12 $\frac{1}{2}$ , at a gain of  $\frac{1}{4}$  of the cost; what was the cost?

57. A's age is 36 years which is  $\frac{4}{5}$  of B's age; how old is B?

58.  $1\frac{1}{11}$  is  $\frac{3}{10}$  of what number?

59.  $4\frac{2}{3}$  is  $\frac{2}{3}$  of what number?

60.  $\frac{1}{4}$  is the ratio of what number to 40?

61.  $\frac{5}{12}$  is the ratio of 10 to what number?

62. A can do a piece of work in 4 days and B can do it in 8 days; in how many days can A and B do it working together?

63. A can do a piece of work in 6 days and B can do it in 10 days; how long would it take the two working together to do it?

64. A and B working together can do a piece of work in 10 days. A could do the same work alone in 15 days; how many days would B require to do the work alone?

65. Two men together earn \$30, and one of them earns  $\frac{2}{3}$  as many dollars as the other; how many dollars does each earn?

66. A man sold a horse for \$70 at a loss of  $\frac{3}{10}$  of the cost of the horse; what did the horse cost?

67. A dealer sold 50 bushels of wheat for \$40 at a loss of  $\frac{1}{5}$  of the cost; what did the wheat cost? How much a bushel?

68. What number is it that on subtracting  $\frac{1}{2}$  of it from  $\frac{7}{8}$  of it the remainder is 12?

69. What number is it that on subtracting  $\frac{2}{3}$  of it from  $\frac{4}{5}$  of it the remainder is 8?

70. What number is it the sum of  $\frac{1}{2}$  and  $\frac{2}{3}$  of which is 35?

71. If 3 men can do a piece of work in 8 days, how long will it take 4 men to do it?

72. If  $\frac{3}{4}$  of a bushel of wheat cost \$ $\frac{9}{10}$ , what will 5 bushels cost?

73. If a loaf of bread cost 5 cents when flour is \$6 a barrel, how many loaves ought to be given for 50 cents when flour is \$5 a barrel?

74. If a man can do  $\frac{2}{3}$  of a piece of work in 5 days, in how many days can he do  $\frac{9}{10}$  of it?

75. A and B have 68 apples, and  $\frac{2}{3}$  of A's number equals  $\frac{1}{4}$  of B's number; how many has each?

CONTRACTED ANALYSIS. —  $\frac{2}{3}$  A's equals  $\frac{1}{4}$  B's; all A's equals  $\frac{3}{8}$  B's; all A's and all B's equals  $\frac{11}{8}$  B's, which equals 68 apples; B's number equals  $\frac{8}{11}$  of 68 apples, or 32 apples; A's number equals  $\frac{3}{8}$  of 32 apples, or 36 apples.

76. A and B have together 62 acres of land, and  $\frac{3}{4}$  of A's number of acres equals  $\frac{2}{3}$  of B's number; how many acres has each?

77. A man paid \$70 for 5 tons of coal and 10 cords of wood, paying  $\frac{2}{3}$  as much for a cord of wood as for a ton of coal; what was the price of the wood per cord? of the coal per ton?

78. How deep in the ground must a 50-foot pole be set so that 2 times the part in the ground shall be  $\frac{3}{11}$  of the part in the air?

79. After a boy had spent  $\frac{1}{3}$  of his money and 4 cents more, he had  $\frac{2}{3}$  of his money left; how many cents had he at first?

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80. What number equals the sum of its  $\frac{2}{3}$ , its  $\frac{1}{10}$  and 6?

81. What number equals the sum of its  $\frac{2}{3}$ , its  $\frac{1}{2}$  and 5?

82. Three fourths of what number is 21 more than  $\frac{1}{4}$  of it?

83. A boy, after spending  $\frac{2}{3}$  of his money, noticed that he had remaining 5 cents less than  $\frac{1}{2}$  of the money he had at first; how much money had he at first?

84. A storm broke off 6 feet less than  $\frac{1}{3}$  of a liberty pole, leaving  $\frac{2}{3}$  of the pole; what was the height of the pole before breaking?

85. A man sold a wagon at a loss of  $\frac{1}{10}$  of its cost. Had he received for the wagon \$8 more than he did, he would have gained  $\frac{1}{4}$  of the cost; what was the cost of the wagon?

86. Two thirds of 30 is  $\frac{1}{4}$  of what number?

87. Seven tenths of 50 is  $\frac{1}{4}$  of what number?

88. Twelve is  $\frac{2}{3}$  of what part of 40?

89. Fifteen is  $\frac{1}{3}$  of what part of 24?

90. Four and one half is  $\frac{3}{4}$  of what part of 10?

91. If 5 men can do a piece of work in 6 days, what part of the work can 3 men do in  $8\frac{1}{2}$  days?

92. If 7 men can earn \$28 in 5 days, how many dollars can 4 men earn in 3 days?

93. If 6 men can earn \$36 in 3 days, how many dollars will 10 men earn in 5 days?

94. How long will 3 barrels of flour last 10 persons if 4 persons eat 2 barrels in 20 weeks?

95. If 6 men can do a piece of work in 8 days, what part of the work can 7 men do in 6 days?

96. A man bought a horse for \$75 and sold it at a gain of  $\frac{1}{5}$  of the cost; how much did he get for it?

97. Three fourteenths is the relation of \$15 to how many dollars?

98. What fraction of the cost of a bicycle is gained by buying it for \$35 and selling it for \$42?

99. A boy 15 years of age is  $\frac{3}{8}$  as old as his father and  $\frac{5}{8}$  as old as his mother; how old are the father and mother?

100. In a school of 63 pupils the number of boys is  $\frac{2}{3}$  of the number of girls; how many of each sex are there?

101. A earned  $\frac{2}{3}$  as much as B, and B earned  $\frac{3}{4}$  as much as C; and together they earned \$54; how many dollars did each earn?

102. A horse and a cow eat a certain quantity of hay in 3 weeks; how long would the same quantity last each alone, if the horse eats only  $\frac{2}{3}$  as much as the cow?

103. A father is 40 years old and the ratio of his age to that of his son is  $2\frac{1}{2}$ ; what was the ratio of the son's age to his father's 4 years ago?

104. The ratio of two numbers is  $\frac{2}{3}$ ; but if 4 be added to the less number the ratio is changed to  $\frac{1}{2}$ ; what are the numbers?

## LESSON XLIII.

## DECIMAL FRACTIONS.

If the unit 1 be divided into 10 equal parts, one of the parts is the fractional unit  $\frac{1}{10}$ .

If the unit  $\frac{1}{10}$  be divided into 10 equal parts, one of the parts is the fractional unit  $\frac{1}{100}$ .

Again, if the unit  $\frac{1}{100}$  be divided into 10 equal parts, one of the parts is the fractional unit  $\frac{1}{1000}$ .

The operation of forming this kind of fractional units may be continued in the same manner to any length at pleasure.

Fractional units formed in this manner are called *decimal fractional units*.

The following are a few collections of decimal fractional units : —

$\frac{3}{10}$ ,  $\frac{7}{10}$ ,  $\frac{9}{100}$ ,  $\frac{23}{100}$ ,  $\frac{67}{100}$ ,  $\frac{19}{1000}$ ,  $\frac{83}{1000}$ ,  $\frac{127}{1000}$ ,  $\frac{811}{1000}$ .

Collections of decimal fractional units are called *decimal fractions*.

The denominators of decimal fractions are always expressed by the figure 1 with a number of ciphers annexed. The denominators are products of the number 10 used some number of times as a factor. Thus, —

the denominator  $100 = 10 \times 10$ ,

the denominator  $1,000 = 10 \times 10 \times 10$ ,

the denominator  $10,000 = 10 \times 10 \times 10 \times 10$ .

Decimal fractions are usually expressed by writing the numerators only, the denominators being indicated by use of a dot prefixed to the expression of the numerators. Thus, —



$\frac{3}{10}$ is written .3;	$\frac{19}{1000}$ is written .019.
$\frac{7}{10}$ is written .7;	$\frac{83}{1000}$ is written .083.
$\frac{9}{100}$ is written .09;	$\frac{127}{1000}$ is written .127.
$\frac{23}{100}$ is written .23;	$\frac{841}{1000}$ is written .841.
$\frac{67}{100}$ is written .67;	$\frac{17}{10000}$ is written .0017.

The dot used in writing decimal fractions is called a *decimal point*.

Decimal fractions expressed by use of the decimal point are usually called *decimals*.

The number of places of figures in the expression of a decimal is the same as the number of ciphers in the expression of the denominator. If, as in some of the examples above, the numerator of the decimal fraction is expressed by a less number of figures than there are ciphers in the expression of the denominator, the deficiency is supplied by prefixing ciphers, before writing the decimal point.

Write the following decimal fractions as decimals. —

- |                       |                      |                      |                        |                        |
|-----------------------|----------------------|----------------------|------------------------|------------------------|
| 1. $\frac{9}{10}$     | 2. $\frac{8}{100}$   | 3. $\frac{11}{1000}$ | 4. $\frac{6}{100}$     | 5. $\frac{123}{1000}$  |
| 6. $\frac{7}{1000}$   | 7. $\frac{29}{1000}$ | 8. $\frac{18}{1000}$ | 9. $\frac{18}{1000}$   | 10. $\frac{117}{1000}$ |
| 11. $\frac{25}{1000}$ | 12. $\frac{87}{100}$ | 13. $\frac{9}{100}$  | 14. $\frac{12}{10000}$ | 15. $\frac{148}{100}$  |

Read the following decimals: —

- |          |          |           |          |           |
|----------|----------|-----------|----------|-----------|
| 1. .123. | 2. .15.  | 3. .003.  | 4. .08.  | 5. .6.    |
| 6. .131. | 7. .14.  | 8. .2.    | 9. .001. | 10. .413. |
| 11. .81. | 12. .03. | 13. .023. | 14. .4.  | 15. .230. |

Integers and decimals may be united in expression, forming what are called *mixed decimals*. Thus 15.007 and 4.06 which are read fifteen and seven thousandths, four and six hundredths, are mixed decimals.

*Questions.*—How many decimal places are required to express numbers of tenths? numbers of hundredths? numbers of thousandths? numbers of ten thousandths?

## LESSON XLIV.

## REDUCTIONS.

## 1. Of Decimals to Common Fractions.—

1. Reduce .6 to a common fraction.

ANALYSIS.—The decimal .6 means the decimal fraction  $\frac{6}{10}$  which reduced to lowest terms is  $\frac{3}{5}$ .

Reduce to common fractions,—

2. .12.	3. .05.	4. .005.	5. .8.	6. .04.
7. .25.	8. .20.	9. .003.	10. .125.	11. .15.
12. .075.	13. .500.	14. .5.	15. .025.	16. .50.
17. .175.	18. .3.	19. .225.	20. .550.	21. .75.

## 2. Of Common Fractions to Decimals.—

22. Reduce  $\frac{1}{5}$  to a decimal.

ANALYSIS.— $\frac{1}{5}$  equals  $\frac{2}{10}$  which, written as a decimal, is .2.

Reduce to decimals,—

23. $\frac{2}{5}$ .	24. $\frac{4}{5}$ .	25. $\frac{1}{2}$ .	26. $\frac{1}{4}$ .	27. $\frac{3}{8}$ .	28. $\frac{5}{8}$ .
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ANALYSIS OF 26TH.—The denominator  $8=2 \times 2 \times 2$ . It therefore lacks the factors, 5, 5, and 5 of being a decimal denominator. We therefore multiply the terms of  $\frac{1}{8}$  by 125, or by 5, 5, and 5 in succession, obtaining  $\frac{125}{800}$ , or .625.

29. Reduce  $\frac{7}{40}$  to a decimal.

ANALYSIS.—The denominator  $40=2 \times 2 \times 2 \times 5$ . It therefore lacks the factors 5 and 5 of being a decimal denominator. We therefore multiply the terms of  $\frac{7}{40}$  by 5 and 5 in succession, obtaining  $\frac{175}{1000}$ , or .175.

Reduce to decimals,—

$$30. \frac{17}{80} \quad 31. \frac{13}{20} \quad 32. \frac{12}{25} \quad 33. \frac{12}{125} \quad 34. \frac{3}{16}$$

ANALYSIS OF 32D.—The factors of 16 are 2, 2, 2, and 2, each of which requires a factor 5 to make up the factors of a decimal denominator. Multiplying the terms of  $\frac{12}{16}$  by 5, 5, 5, and 5 in succession gives  $\frac{1875}{10000}$ , or .1875.

Express decimally,—

$$\begin{array}{lllll} 35. \$5\frac{1}{2} & 36. \$10\frac{1}{4} & 37. \$7\frac{1}{8} & 38. \$4\frac{1}{2} & 39. \$2\frac{1}{4} \\ 40. \$3\frac{1}{2} & 41. \$7\frac{1}{8} & 42. \$12\frac{3}{8} & 43. \$2\frac{2}{5} & 44. \$5\frac{1}{10} \end{array}$$


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## LESSON XLV.

### ADDITION AND SUBTRACTION.

1. What is the sum of  $\frac{3}{10}$  and  $\frac{4}{10}$ ? of .7 and .4?
2. What is the sum of .8, .7, and .5?
3. What is the sum of  $\frac{3}{100}$ ,  $\frac{12}{100}$ , and  $\frac{5}{100}$ ?
4. What is the sum of .05, .08, and .04?
5. What is the sum of .09, .23, and .17?
6. What is the sum of 5.31 and 2.12?
7. Add .05, .12, and .25.    8. Add .3, .07, and .5.
9. Add .13, .09, and .003.    10. Add .003, .004, and .002.
11. From  $\frac{7}{10}$  subtract  $\frac{3}{10}$ .    12. From .8 subtract .5.
13. From 4.23 subtract 2.15.    17.  $\$6.37 - \$2.12 = ?$
14. From \$5.25 subtract \$3.20.    18.  $\$5.00 - \$3.20 = ?$
15. From \$10.35 subtract \$4.18.    19.  $\$2.50 - \$1.75 = ?$
16. From \$12.205 subtract \$6.25.    20.  $\$7.25 - \$4.50 = ?$
21. A man bought a coat for \$12.50 and a pair of pants for \$4.75. He gave in payment two 10-dollar bills; how much money should he receive back in change?

22. A man owed \$30.65, he paid at one time \$20, and at another time \$7.50, how many dollars did he still owe?

23. The footing of the credit side of an account was \$8.40, and of the debit side was \$12.75, what should be the entry to balance account?

24. What sum should be added to .055 to equal the sum of .2, .05, and .025?

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## LESSON XLVI

### MULTIPLICATION AND DIVISION.

1. What is the product of  $\frac{2}{10}$  by 3? of .2 by 4?
2. What is the product of  $\frac{7}{100}$  by 9? of .12 by 7?
3. Multiply .23 by 2.
4. Multiply .15 by 5.
5. Multiply .17 by 3.
6. Multiply .18 by 4.
7. Multiply .008 by 7.
8. Multiply .014 by 6.
9. Multiply \$3.15 by 3.
10. Multiply \$4.18 by 5.
11. Divide .56 by 8.
12. Divide .045 by 9.
13. Divide .124 by 4.
14. Divide \$10.25 by 5.
15. Divide \$3.30 by 6.
16. Divide \$8.56 by 4.
17. What will 4 barrels of flour cost at \$6.25 a barrel?
18. What will a man earn in 5 days at \$1.20 a day?
19. What distance can a man walk in 6 hours at the rate of 3.12 miles an hour?
20. At \$1.10 a dozen, what will 50 dozen combs cost?
21. A man divided 20.32 bushels of oats into 4 equal portions; how many bushels were there in each portion?
22. How long will it take a man to walk 30.24 miles at the rate of 3 miles an hour?

23. Paid \$35.25 for 5 weeks' labor; what was the cost of the labor per week?

24. What will 15 pounds of sugar cost at 6.5 cents a pound?

25. If 5.4 barrels of flour be equally divided among 6 families, how much will each family receive?

26. Multiply  $\frac{7}{10}$  by 10; by 100; by 1,000.

27. Multiply .3 by 10; .9 by 100; .12 by 1,000.

28. Divide  $\frac{7}{10}$  by 10; .03 by 10; by 100.

29. Multiply .15 by 10; by 100; by 1,000.

30. Divide 2.5 by 10; by 100; by 1,000

**Principles: —**

1. A decimal is multiplied by 10, 100, 1,000, etc., by moving the decimal point as many places toward the right as there are ciphers in the multiplier.

2. A decimal is divided by 10, 100, 1,000, etc., by moving the decimal point as many places toward the left as there are ciphers in the divisor.

31. Multiply 5.06 by .3; by .4; by .5; by .6.

ANALYSIS.—To multiply 5.06 by .3 is to find  $\frac{3}{10}$  of 5.06;  $\frac{3}{10}$  of 5.06 is .506 (principle 2, above), and  $\frac{3}{10}$  of 5.06 is 3 times .506, or 1.518.

32. Multiply 12.15 by .04; by .05; by .06; by .03.

33. Divide 8.24 by .2; by .4; by .8.

ANALYSIS.—To divide 8.24 by .2 is to find  $\frac{1}{2}$  of 10 times 8.24; 10 times 8.24 is 82.4 (principle 1, above), and  $\frac{1}{2}$  of 82.4 is 41 2.

34. Divide 7.2 by .03; by .04; by .06; by .12.

SUGGESTION.—Multiplying 7.2 by 100 requires annexing a cipher. Thus, 100 times 7.2 is 720.

## LESSON XLVII.

## DENOMINATE NUMBERS.

In the expression 6 feet, the unit *one* foot is 12 times the unit *one* inch, or  $\frac{1}{12}$  of the unit *one* yard. Thus, the units *one* foot, *one* inch, and *one* yard are related to each other. They are called *related units*.

So also in the expression 10 minutes, the unit *one* minute is related to the units *one* second, *one* hour, *one* day, etc.

Numbers like 6 and 10 in the expressions 6 feet, 16 minutes, are called *denominate numbers*.

**A Denominate Number** is a concrete number whose unit is a related unit.

Orders of related units, as inches, feet, yards, rods, miles, or pints, quarts, gallons, are called *denominations*.

A number, as 3 days 6 hours 20 minutes 15 seconds, formed by uniting two or more numbers of related denominations is called a *compound number*.

## UNITED STATES MONEY.

*Denominations*.— Mills, cents, dimes, dollars, eagles.

## RELATIONS OF UNITS.

10 mills (m)	= 1 cent, ct.
10 cents	= 1 dime, d.
10 dimes	= 1 dollar, \$.
10 dollars	= 1 eagle, E.

How many mills in 4 cents?

ANALYSIS.— In 1 cent there are 10 mills; in 4 cents there are 4 times 10 mills, or 40 mills.

1. How many mills in 3 cents? in 6 cents? in 8 cents?
2. How many cents in 4 dimes? in 7 dimes? in 5 dimes?
3. How many dimes in \$6? in \$9? in \$4? in \$7?
4. How many cents in \$1? in \$3? in \$5? in \$6?

How many dollars in 50 dimes?

ANALYSIS.—There are 10 dimes in one dollar; in 50 dimes there are as many dollars as 10 dimes is contained times in 50 dimes, or \$5.

ANOTHER ANALYSIS.—There are 10 dimes in \$1, hence the number of dollars equals  $\frac{1}{10}$  of the number of dimes.  $\frac{1}{10}$  of 50 is 5; then in 50 dimes there are \$5.

5. How many dollars in 90 dimes? in 40 dimes? in 70 dimes?

6. How many dimes in 60 cents? in 80 cents? in 30 cents?

7. How many dollars in 300 cents? in 700 cents? in 500 cents?

8. How many cents in 3 dimes and 7 cents? in 5 dimes and 4 cents? in 8 dimes and 9 cents? in 2 dimes 3 cents?

9. How many cents in \$3 4 d. 5 ct.? in \$6 7 d. 8 ct.? in \$4 6 d. 3 ct.?

10. How many dollars, dimes, and cents in 245 cents?

11. How many dollars, dimes, and cents in 584 cents?

12. How many dollars and cents in 746 cents?

13. How many dimes and cents in 359 cents?

14. What part of a dollar is 2 dimes? 8 dimes? 5 dimes?

15. What part of a dollar is 2 dimes 5 cents? 3 d. 5 ct.?

16. Add 3 d. 6 ct. and 4 d. 3 ct.; 5 d. 4 ct. and 2 d. 6 ct.; 7 d. 8 ct. and 5 d. 5 ct.

17. John had 2 d. 8 ct. and Henry had 4 d. 7 ct.; how many dimes and how many cents besides did the two have together?

18. A father gave to each of his two sons 3 d. 8 ct.; how many dimes and cents did he give to both together?

19. What is  $\frac{1}{2}$  of 6 d. 8 ct.? of 7 d. 6 ct.? of 5 d. 8 ct.?

20. What is  $\frac{1}{3}$  of 9 d. 6 ct.? of 8 d. 7 ct.? of 7 d. 5 ct.?

## LESSON XLVIII.

### ENGLISH MONEY.

*Denominations.*— Farthings, pence, shillings, pounds, guineas.

#### RELATIONS OF UNITS.

4 farthings (far.)	= 1 penny, d.
12 pence	= 1 shilling, s.
20 shillings	= 1 pound, £.
21 shillings	= 1 guinea, G.

How many farthings in 5 pence?

ANALYSIS.— In 1 penny there are 4 farthings; in 5 pence there are 5 times 4 farthings, or 20 farthings.

1. How many farthings in 7 pence? in 10 pence? in 8 pence? in 3 pence? in 6 pence?

2. How many pence in 5 shillings? in 7 shillings?

SUGGESTION.— The number of pence in any number of shillings is 12 times the number of the shillings.

3. How many shillings in £3? in £5? in £4?

4. How many shillings in £2 7 s.? in £4 10 s.?

5. How many pence in 8 far.? in 20 far.? in 32 far.?

6. How many pence and farthings in 15 far.? in 25 far.? in 38 far.? in 47 far.? in 59 far.?

7. How many pounds in 40 s.? in 80 s.? in 60 s.?



8. How many pounds and shillings in 23 s. ? in 35 s. ?  
in 46 s. ? in 58 s. ? in 84 s. ?
9. How many farthings in 5 d. 3 far. ? in 7 d. 1 far. ?
10. How many shillings in 48 d. ? in 60 d. ? in 84 d. ?
11. How many shillings and pence in 40 d. ? in 54 d. ?  
in 65 d. ? in 73 d. ? in 90 d. ? in 86 d. ?
12. What is the sum of £2 13 s. and £4 7 s. ?
13. What is 2 times 3 s. 6 d. ? 2 times £4 15 s. ?
14. What is  $\frac{1}{2}$  of 4 s. 10 d. ? of 7 s. 8 d. ? of £9 12 s. ?
15. What is the relation of £1 5 s. to £3 10 s. ?
16. What is the relation of 3 s. 6 d. to 4 s. 8 d. ?
17. What part of 8 pence is 3 farthings ?
18. What part of 3 s. 4 d. is 2 s. 6 d. ?
19. What part of a guinea is  $\frac{3}{4}$  of a pound ?
20. How many shillings in 2 guineas ? in 3 guineas 5  
shillings ? in 4 guineas 6 shillings ?

## LESSON XLIX.

### LINEAR MEASURE.

*Denominations.*—Inches, feet, yards, rods, miles.

#### RELATIONS OF UNITS.

12 inches (in.)	= 1 foot, ft.
3 feet	= 1 yard, yd.
$5\frac{1}{2}$ yd. or $16\frac{1}{2}$ ft.	= 1 rod, rd.
320 rods	= 1 mile, mi.

1. How many inches in 3 ft. ? in 5 ft. ? in 8 ft. ?
2. How many feet in 48 in. ? in 60 in. ? in 84 in. ?
3. How many feet and inches in 38 in. ? in 53 in. ? in  
64 in. ? in 79 in. ? in 90 in. ? in 50 in. ? in 83 in. ?

4. How many feet in 5 yd.? in 3 yd.? in 8 yd.?
5. How many yards in 12 ft.? in 27 ft.? in 42 ft.?
6. How many feet in 2 yd. 2 ft.? in 4 yd. 1 ft.? in 6 yd. 2 ft.?
7. How many yards and feet in 25 ft.? in 37 ft.? in 44 ft.? in 58 ft.? in 61 ft.?
8. How many yards in 2 rd.? in 5 rd.? in 8 rd.?
9. How many feet in 2 rd.? in 3 rd.? in 4 rd.?
10. How many feet in 3 rd. 5 ft.? in 4 rd. 10 ft.?
11. What part of a yard is 1 ft. 8 in.? is 2 ft. 3 in.?
12. What part of a yard is 2 ft. 6 in.? is 2 ft. 8 in.?
13. What part of a rod is 1 ft.? is  $5\frac{1}{2}$  ft.? is 2 yd.?
14. How many feet in 2 rd. 3 yd.? in 3 rd.  $\frac{1}{2}$  yd.?
15. How many rods in a mile? in 2 mi.? in 3 mi.?
16. How many inches in 5 ft. 8 in.? in 7 ft. 6 in.?
17. How many inches in 1 yd. 6 in.? in 2 yd.? in  $\frac{3}{4}$  yd.? in  $2\frac{3}{4}$  yd.? in 1 yd.  $1\frac{3}{4}$  ft.?
18. How many rods in  $\frac{1}{2}$  mi.? in  $\frac{1}{4}$  mi.? in  $\frac{1}{8}$  mi.?
19. How many feet in  $\frac{1}{2}$  of a rod? in  $\frac{1}{8}$  of a rod?
20. What is 2 times 1 ft. 6 in.? What is 3 times 2 yd. 1 ft.? What is  $5\frac{1}{2}$  times 7 yd.?

## LESSON L.

### SQUARE MEASURE.

*Denominations.*—Square inches, square feet, square yards, square rods, acres.

#### RELATIONS OF UNITS.

144 square inches (sq. in.)	= 1 square foot,	sq. ft.
9 square feet	= 1 square yard,	sq. yd.
$30\frac{1}{4}$ square yards	= 1 square rod,	sq. rd.
160 square rods	= 1 acre,	A.

1. How many square feet in 3 sq. yd.? in 5 sq. yd.? in 8 sq. yd.? in 4 sq. yd.? in 7 sq. yd.?

2. How many square yards in 54 sq. ft.? in 81 sq. ft.? in 72 sq. ft.? in 99 sq. ft.?

3. How many square rods in 2 A.? in 3 A.? in  $\frac{1}{2}$  A.? in  $\frac{1}{4}$  A.? in  $\frac{1}{8}$  A.? in  $\frac{1}{16}$  A.?

4. In a slate 8 inches long and 6 inches wide, how many square inches can be marked off along the side? How many such rows of square inches can be marked off on the whole slate? Eight square inches in a row and 6 rows would make how many square inches?

5. In the same slate how many square inches can be marked off along the end? How many such rows would cover the whole slate? Six square inches in a row along the end of the slate, and 8 such rows would make how many square inches in the entire surface of the slate?

6. How many square inches in a surface 10 inches long and 7 inches wide?

**SUGGESTION.**—Think how many square inches there would be in a row along the side or along the end of the surface, and then think how many such rows there would be.

7. How many square inches in a surface 7 in. by 9 in.? 8 in. by 12 in.? 5 in. by 11 in.? 6 in. by 10 in.? 12 in. by 12 in.?

8. How many square feet in a garden plat that is 20 feet long and 8 feet wide?

**Questions.**—How many square feet in a row? How many rows?

9. How many square feet in a surface that is 7 ft. by 12 ft.? 8 ft. by 10 ft.? 5 ft. by 15 ft.? 6 ft. by 20 ft.?

10. How many square yards in a surface that is 6 yd. by

11 yd.? 8 yd. by 12 yd.? 7 yd. by 9 yd.? 5 yd. by 20 yd.?

11. How many square rods in a surface that is 8 rd. by 10 rd.? 10 rd. by 10 rd.? 5 rd. by 15 rd.? 7 rd. by 14 rd.?

12. How many acres in a piece of ground that is 20 rods long and 8 rods wide? in one that is 16 rods long and 10 rods wide? in one that is 5 rd. by 32 rd.? 4 rd. by 40 rd.? 2 rd. by 80 rd.?

13. How many acres in a piece of ground 20 rods long and 16 rods wide? in one 48 rods long and 10 rods wide? in one 32 rods long and 20 rods wide?

14. How many acres in 200 sq. rd.? in 500 sq. rd.?

15. How many square feet in a garden that is 120 feet long and 60 feet wide? How many square yards in the garden?

16. A piece of ground containing 4 square rods is what part of one that is 4 rods square?

17. A piece of ground 9 rods long and 7 rods wide is what part of one 12 rods long and 6 rods wide?

18. What part of an acre is a piece of ground 10 rods long and 8 rods wide? a piece that is 24 rods long and 5 rods wide? a piece that is 8 rods square? a piece 10 rods square? a piece that is 12 rods square?

19. How many square yards of plastering in the ceiling of a room that is 15 feet long and 12 feet wide?

20. How many square yards of pavement in a walk that is 5 feet wide and 30 feet long?

21. How many square feet of lumber in 4 boards, 12 feet long and 1 foot wide?

22. How many square feet of lumber in 6 boards, 12 feet long and 6 inches wide?

23. How many square feet of lumber in 8 boards, 16 feet long and 12 inches wide?

24. What will it cost for a concrete walk 6 feet wide and 60 feet long at  $\$1\frac{1}{4}$  a square yard?

25. What will the lumber cost for the floor of a room 20 feet long and 15 feet wide at \$20 a thousand?

*Question.*—What part of 1,000 sq. ft. is the number of square feet in the floor?

## LESSON LI.

### CUBIC MEASURE.

*Denominations.*—Cubic inches, cubic feet, cubic yards, cords.

#### RELATIONS OF UNITS.

1,728 cubic inches (cu. in.)	= 1 cubic foot,	cu. ft.
27 cubic feet	= 1 cubic yard,	cu. yd.
128 cubic feet	= 1 cord of wood,	C.

*NOTE.*—A cubic yard of earth is called a *load*. One eighth of a cord of wood, or 16 cu. ft., is called a *cord foot*.  $24\frac{1}{2}$  cu. ft. of stone or masonry is called a *perch*.

1. How many cubic inches in a block 5 inches long, 4 inches wide, and 3 inches thick?

*Questions.*—How many square inches in the surface which is 4 in. by 5 in.? How many cubic-inch blocks could be placed upon that surface? How many such tiers of cubic-inch blocks would there be in a pile 3 inches high? How many cubic inches would there be then in a block 5 in. long, 4 in. wide, and 3 in. thick?

2. How many cubic inches in a block 8 in. long, 5 in. wide, and 4 in. thick?

3. How many cubic feet in a cubic yard? Show why.

4. How many cubic feet in 2 cu. yd.? in 3 cu. yd.?

5. How many cubic feet in  $2\frac{1}{2}$  cu. yd.? in  $2\frac{3}{4}$  cu. yd.? in  $3\frac{1}{2}$  cu. yd.?

6. How many cubic yards in 54 cu. ft.? in 60 cu. ft.? in 81 cu. ft.? in 90 cu. ft.?

7. How many cubic yards of earth will be removed in digging a cellar 8 yards long, 5 yards wide, and  $2\frac{1}{2}$  yards deep?

8. How many cubic feet in a cellar 15 feet long, 12 feet wide, and 6 feet deep? How many cubic yards?

9. How many cubic feet in a stick of timber 16 feet long, 2 feet wide, and 2 feet thick?

10. How many cubic feet in a stick of timber 20 ft. by 3 ft. by 2 ft.?

11. How many cords in a pile of wood 8 ft. long, 4 ft. wide, and 4 ft. high?

12. How many cords of wood in a pile 16 ft. long, 4 ft. wide, and 8 ft. high?

13. How many cords of wood in a pile 40 ft. long, 4 ft. wide, and 6 ft. high?

14. What part of a cord of wood is a pile 6 ft. long, 4 ft. wide, and 3 ft. high?

15. What will a pile of wood 32 ft. long, 4 ft. wide, and 6 ft. high cost at  $\$4\frac{1}{2}$  a cord?

NOTE.—A cord of stove wood is equivalent to a pile 8 feet long and 4 feet high without regard to the length of the sticks.

16. What will a pile of stove wood 24 ft. long and 5 ft. high cost at \$2 a cord?

17. What will be the cost of a pile of stove wood 28 ft. long and 6 ft. high at  $\$2\frac{1}{2}$  a cord?

18. If a bushel of wheat is equal to  $1\frac{1}{2}$  cubic feet, how many bushels will a bin contain that is 5 ft. long, 4 ft. wide, and 6 ft. deep?

19. What will it cost to dig a cellar 12 ft. long, 9 ft. wide, and 6 ft. deep at  $\$ \frac{1}{2}$  a cubic yard?

20. What will be the cost of a stick of timber 2 feet square at the ends and 18 feet long at  $\$ \frac{1}{8}$  a cubic foot?

## LESSON LII.

### AVOIRDUPOIS WEIGHT.

*Denominations.*—Ounces, pounds, hundredweight, tons.

#### RELATIONS OF UNITS.

16 ounces (oz.)	= 1 pound,	lb.
100 pounds	= 1 hundredweight,	cwt.
20 hundredweight	= 1 ton,	T.

- How many ounces in 2 lb.? in 4 lb.? in 6 lb.?
- How many ounces in  $3\frac{1}{2}$  lb.? in  $4\frac{3}{4}$  lb.? in  $5\frac{1}{2}$  lb.?
- How many pounds in 32 oz.? in 48 oz.? in 80 oz.?
- How many pounds and ounces in 40 oz.? in 52 oz.?  
in 60 oz.? in 75 oz.? in 100 oz.?
- How many pounds in 2 cwt.? in 8 cwt.? in 15 cwt.?
- How many pounds in  $4\frac{1}{2}$  cwt.? in  $5\frac{1}{2}$  cwt.? in  $9\frac{1}{2}$  cwt.? in  $12\frac{3}{4}$  cwt.? in  $15\frac{1}{2}$  cwt.?
- How many hundredweight in 500 lb.? in 1,200 lb.? in 1,500 lb.? in 1,700 lb.? in 2,000 lb.?
- How many hundredweight and pounds in 415 lb.? 820 lb.? 1,050 lb.? 2,005 lb.?
- How many hundredweight in two tons? in  $3\frac{1}{2}$  tons? in  $4\frac{3}{4}$  tons? in  $2\frac{1}{2}$  tons?

10. How many tons in 3,000 lb.? in 4,000 lb.? in 5,000 lb.? in 56 cwt.? in 64 cwt.? in 65 cwt.?
11. What will  $2\frac{1}{4}$  lb. of butter cost at 16 cents a pound?
12. What will 3 lb. 8 oz. of butter cost at 20 cents a pound?
13. What will 5 lb. 2 oz. of pork cost at 8 cents a pound?
14. What part of a ton is 4 cwt.? 10 cwt.? 12 cwt.? 15 cwt.? 18 cwt.? 1,750 lb.?
15. What will 16 cwt. of hay cost at \$10 a ton? at \$12 a ton? at \$15 a ton?
16. What will 320 lb. of flour cost at \$4 a hundred?
17. What will 7 cwt. of hay cost at \$8 a ton?
18. What will 3 cwt. of pork cost at the rate of \$10 a barrel (200 lb.)?
19. What will 75 lb. of pork cost at the rate of \$8 a barrel?
20. What will  $12\frac{1}{2}$  cwt. of hay cost at \$10 a ton?

## LESSON LIII.

### TROY WEIGHT.

Used in weighing gold, silver, and precious stones.

*Denominations.*— Grains, pennyweights, ounces, pounds.

#### RELATIONS OF UNITS.

24 grains (gr.)	=	1 pennyweight, pwt.
20 pennyweights	=	1 ounce, oz.
12 ounces	=	1 pound, lb.

1. How many grains in 2 pennyweights? in 3 pwt.?
2. How many pennyweights in 72 gr.? in 96 gr.?
3. How many pennyweights in 3 oz.? in 5 oz.? in 8 oz.?



4. How many ounces in 40 pwt.? in 60 pwt.? in 75 pwt.? in 90 pwt.? in 100 pwt.?
5. How many ounces in 3 lb.? in 5 lb.? in 7 lb.? in 10 lb.? in 12 lb.?
6. How many pounds in 24 oz.? in 30 oz.? in 36 oz.? in 50 oz.? in 68 oz.?
7. How many ounces in 2 lb. 6 oz.? in 3 lb. 10 oz.? in 4 lb. 8 oz.? in  $5\frac{3}{4}$  lb.?
8. How many pennyweights in 3 oz. 5 pwt.? in 4 oz. 10 pwt.? in  $5\frac{3}{4}$  oz.?
9. What part of a pound is 2 oz. 8 pwt.?
10. If a gold dollar weighs  $25\frac{1}{4}$  gr. what will 5 gold dollars weigh?
11. How many spoons each weighing  $1\frac{1}{2}$  oz. may be made from 1 lb. 3 oz. of silver?
12. What is the value of 3 oz. of gold, if 3 pwt. are worth \$3?

## LESSON LIV.

### DRY MEASURE.

*Denominations.*—Pints, quarts, pecks, bushels.

#### RELATIONS OF UNITS.

2 pints (pt.)	=	1 quart, qt.
8 quarts	=	1 peck, pk.
4 pecks	=	1 bushel, bu.

1. How many pints in 4 qt.? in 7 qt.? in 10 qt.? in 18 qt.? in 25 qt.?
2. How many quarts in 12 pt.? in 20 pt.? in 38 pt.? in 43 pt.? in 65 pt.?

3. How many quarts in 2 pk.? in 1 bu.? in 3 pk.? in  $2\frac{1}{2}$  pk.? in  $3\frac{1}{2}$  pk.?
4. How many pecks in 5 bu.? in  $7\frac{1}{2}$  bu.? in  $10\frac{1}{2}$  bu.? in 12 bu.? in  $15\frac{1}{2}$  bu.?
5. How many bushels in 28 pk.? in 40 pk.? in 53 pk.? in 63 pk.? in 70 pk.?
6. How many quarts in 3 pk. 2 qt.? in 1 bu. 1 pk.? in 2 pk. 7 qt.? in 2 bu. 5 qt.? in 1 bu. 2 pk. 3 qt.?
7. What part of a bushel is 2 pk. 4 qt.?
8. What part of a bushel is  $1\frac{1}{2}$  pk.?
9. What is a peck of wheat worth at the rate of  $\$1\frac{1}{2}$  a bushel?
10. What will 2 bu. of berries cost at 10 cents a quart?

## LESSON LV.

### LIQUID MEASURE.

*Denominations.*—Gills, pints, quarts, gallons, barrels.

#### RELATIONS OF UNITS.

4 gills (gi.)	= 1 pint,	pt.
2 pints	= 1 quart,	qt.
4 quarts	= 1 gallon,	gal.
$31\frac{1}{2}$ gallons	= 1 barrel,	bbl.

1. How many gills in 2 pt.? in 4 pt.? in 7 pt.? in 10 pt.? in 20 pt.?
2. How many pints in 12 gi.? in 20 gi.? in 30 gi.? in 40 gi.? in 49 gi.?
3. How many pints in 3 qt.? in 6 qt.? in 12 qt.? in  $8\frac{1}{2}$  qt.? in  $15\frac{1}{2}$  qt.?
4. How many quarts in 8 pt.? in 15 pt.? in 20 pt.? in 25 pt.? in 50 pt.?

5. How many quarts in 5 gal.? in 9 gal.? in 12 gal.? in  $17\frac{1}{4}$  gal.? in  $23\frac{1}{2}$  gal.?

6. How many gallons in 8 qt.? in 11 qt.? in 16 qt.? in 20 qt.? in 30 qt.?

7. How many gallons in 2 bbl.? in 3 bbl.?

8. How many pints in 2 gal. 3 qt.? in 3 gal. 2 qt.? in 4 gal. 3 qt. 1 pt.?

9. How many gills in 1 pt. 3 gi.? in 1 qt. 1 pt. 1 gi.? in 2 qt. 2 gi.?

10. What part of a gallon is  $2\frac{1}{2}$  qt.? is  $3\frac{1}{2}$  qt.? is  $1\frac{1}{4}$  pt.?

11. What will a pint of vinegar cost at 40 cents a gallon?

12. How many gallons in a barrel? in 2 bbl.?

13. What part of a barrel is 14 gallons?

14. What will 21 gal. of cider cost at  $\$2\frac{1}{4}$  a barrel? What will 10 gal. cost?

15. If a cistern leaks 5 gal. an hour, how many barrels will it leak in  $12\frac{3}{4}$  hours? In what time will it leak 3 bbl.?

## LESSON LVI.

### TIME.

*Denominations.*— Seconds, minutes, hours, days, weeks, years.

#### RELATIONS OF UNITS.

60 seconds (sec.) = 1 minute, min.

60 minutes = 1 hour, hr.

24 hours = 1 day, da.

7 days = 1 week, wk.

365 days = 1 year.

366 days = 1 leap year.

100 years = 1 century.

1. How many seconds in 5 minutes? in 8 minutes? in 10 min.?

2. How many minutes in 120 sec.? in 40 sec.? in 90 sec.? in 300 sec.?

3. How many minutes in 3 hr.? in 5 hr.? in 8 hr.? in  $2\frac{1}{2}$  hr.? in  $3\frac{3}{4}$  hr.?

4. How many hours in 180 min.? in 240 min.? in 300 min.?

5. How many hours in 2 da.? in 3 da.? in 5 da.? in  $4\frac{1}{2}$  da.? in  $3\frac{3}{4}$  da.?

6. How many days in 72 hr.? in 56 hr.? in 96 hr.? in 112 hr.?

7. How many days in 3 wk.? in 7 wk.? in 10 wk.?

8. How many weeks in 21 da.? in 30 da.? in 42 da.? in 45 da.? in 54 da.?

9. What part of a year is 7 wk. 3 da.?

10. What part of a day is  $4\frac{1}{2}$  hr.?  $4\frac{1}{2}$  hr.?  $5\frac{1}{2}$  hr.?

11. What part of an hour is  $6\frac{3}{4}$  min.? is  $7\frac{1}{2}$  min.? is 20 min.?

12. A man starts at half-past 7 in the morning and walks at the rate of 4 mi. an hour; how far will he have walked at 15 minutes before 12 o'clock?

13. A man starts at 15 minutes before 6 o'clock in the morning and reaches a place  $17\frac{1}{4}$  miles distant at half-past 11 o'clock. At what rate per hour did he travel?

14. How long time is it from 8 min. past 5 o'clock in the morning to 5 min. past 8 o'clock the same morning?

15. If a clock lose 1 min. in 12 hours, and the hands are set together at 12 noon, true time, on Sunday, what time will the hands indicate at true noon on Tuesday?

**Principle: —**

Every year whose number is divisible by 4 is a leap year, except the centennial years that are not divisible by 400.

## LESSON LVII.

## CIRCULAR OR ANGULAR MEASURE.

*Denominations.*—Seconds, minutes, degrees, circumferences.

## RELATIONS OF UNITS.

60 seconds (") = 1 minute, (')

60 minutes = 1 degree, (°)

360 degrees = 1 circumference, (C.)

1. How many seconds in 2'? in  $2\frac{1}{3}'$ ? in  $1\frac{3}{4}'$ ?
2. How many minutes in 90''? in 120''? in 300''?
3. How many minutes in  $1\frac{1}{2}^\circ$ ? in  $2\frac{1}{3}^\circ$ ? in  $3^\circ$ ?
4. How many degrees in 120'? in 200'? in 240'?
5. How many degrees in  $\frac{1}{2}$  C.? in  $\frac{1}{4}$  C.? in  $\frac{1}{8}$  C.?  
in  $\frac{1}{16}$  C.?

NOTE.— $\frac{1}{2}$  C. is a *semi circumference*;  $\frac{1}{4}$  C. is a *quadrant*;  $\frac{1}{8}$  C. is a *sextant*;  $\frac{1}{16}$  C. is a *sign*; in Astronomy.

6. The earth completes one rotation ( $360^\circ$ ) upon its axis in 24 hours; through how many degrees does it turn in 1 hour.

7. In what time does the earth turn  $1^\circ$ ?  $1'$ ?

## LESSON LVIII.

## MISCELLANEOUS TABLE.

12 things = 1 dozen, doz.	24 sheets = 1 quire, qr.
12 dozen = 1 gross, gr.	20 quires = 1 ream, rm.
12 gross = 1 great gross, g. gr.	2 reams = 1 bundle, bdl.
20 things = 1 score, sc.	5 bundles = 1 bale, bl.

1. How many are  $3\frac{1}{2}$  doz.?  $2\frac{1}{2}$  gr.? 3 score and 10?
2. How many dozen in 60 eggs? in 75 clothes-pins?
3. How many score in 5 doz.? in  $6\frac{1}{2}$  doz.? in 100?
4. How many sheets of paper in 2 qr.? in  $3\frac{1}{2}$  qr.? in 4 qr.?
5. How many quires in 30 sheets? in 48 sheets? in 60 sheets.
6. A man bought some articles at 4 cents per doz., and sold them at 5 cents per score; what part of the cost did he gain or lose?
7. A stationer bought paper at \$2 a ream and retailed it at  $\frac{1}{2}$  cent a sheet; what part of the cost of the paper did he gain?

## QUIZ FOR REVIEW.

- |                           |                           |
|---------------------------|---------------------------|
| 1. Pk. in 1 bu.?          | 21. S. in £1?             |
| 2. Rd. in 1 mi.?          | 22. Qt. in 1 gal.?        |
| 3. Deg. in 1 circle?      | 23. Lb. in 1 ton?         |
| 4. Pwt. in 1 lb.?         | 24. Gr. in 1 pwt.?        |
| 5. Ft. in 1 rd.?          | 25. Gi. in 1 pt.?         |
| 6. Oz. in 1 lb. (Troy)?   | 26. Min. in 1°?           |
| 7. M. in \$1?             | 27. D. in 1 s.?           |
| 8. Sheets in 1 qr.?       | 28. Cu. ft. in 1 C.?      |
| 9. Cu. in: in 1 cu. ft.?  | 29. Cu. ft. in 1 cu. yd.? |
| 10. Yd. in 1 rd.?         | 30. S. in 1 G.?           |
| 11. Things in 1 gr.?      | 31. Min. in 1 hr.?        |
| 12. Sq. rd. in 1 A.?      | 32. Qt. in 1 bbl.?        |
| 13. Qt. in 1 pk.?         | 33. Cd. ft. in 1 C.?      |
| 14. Gal. in 1 bbl.?       | 34. D. in \$1?            |
| 15. Qr. in 1 rm.?         | 35. Pt. in 1 pk.?         |
| 16. In. in 1 yd.?         | 36. Lb. in cwt.?          |
| 17. Sq. yd. in 1 sq. rd.? | 37. Deg. in 1 quadrant?   |
| 18. Things in 1 score?    | 38. Pt. in 1 gal.?        |
| 19. Qt. in 1 bu.?         | 39. Cu. yd. in one load?  |
| 20. Sq. ft. in 1 sq. yd.? | 40. Min. in 1 da.?        |

## LESSON LIX.

## MISCELLANEOUS PROBLEMS.

1. What will one bbl. of cider cost at 4 cents a gallon?
2. If a man earn 12 cents an hour how much will he earn in  $\frac{7}{10}$  of a day (10 hours)?
3. What will 4 cwt. of sugar cost at 4 cents a pound?
4. What will 16 sheets of paper cost at \$15 a ream?
5. If I pay \$3.20 for a bushel of strawberries, how much is that for 1 qt.?
6. What will 25 bbl. of flour cost at \$3 per hundred-weight?
7. A boy picked a peck of cherries which he sold at 4 cents a pint; how much did he receive for them?
8. A merchant bought  $\frac{3}{4}$  doz. hand-saws at \$18 a dozen; how shall he sell them to gain 25 cents apiece?
9. A man bought a bushel of cranberries for \$6.40; how much a quart must he get for them to gain 2 cents a pint?
10. A man bought 25 acres of land for \$300. He sold it at a gain of  $\frac{1}{4}$  of the cost; what did he gain per acre?
11. What will 10 gal. molasses cost at 5 cents a pint?
12. What will 5 bu. beans cost at 4 cents a quart?
13. What will 20 cords of wood cost at  $\$ \frac{1}{2}$  a cord foot?
14. What would a piece of land 5 rods by 10 rods cost, at the rate of \$80 an acre?
15. What would 20 boards 12 feet long and 15 inches wide cost at the rate of \$15 a thousand?
16. What part of an acre is a piece of land 16 rd. long and 7 rd. wide?
17. A schoolroom is 10 yd. long, 8 yd. wide, and 5 yd. high, and accommodates 50 pupils; how long will the air

in this room be fit for breathing, if a single pupil requires 10 cu. yd. an hour?

18. How many yards of carpet  $\frac{3}{4}$  yd. wide will it take to cover the floor of a room 8 yd. long and 6 yd. wide? What will the carpet cost at \$ $\frac{5}{8}$  a yard?

19. How many thousand shingles will it take to cover a surface 20 ft. by 30 ft., if a thousand cover a surface 10 ft. square.

20. How many feet of flooring will it take for a room 20 ft. long and 15 ft. wide, allowing  $\frac{1}{8}$  for matching?

21. How many thousand brick will it take to build a 12-inch wall 30 ft. long and 20 ft. high, if it takes 20 bricks to every square foot of surface of wall? what will the brick cost at \$8 a thousand?

22. If a horse eats  $1\frac{1}{2}$  pk. of oats in one day, how many days will 6 bu. last?

23. A grocer paid \$14 for 20 bu. of potatoes, and re-tailed them at 21 cents a peck; what part of the cost was the selling price?

24. A railroad train runs 84 mi. in 4 hr.; how many rods does it run in 1 min.?

25. How many tile each  $1\frac{1}{2}$  ft. in length will it require for 8 rd. of drain?

26. How many acres in 10 miles of a 4-rod road?

27. How many feet in a board 15 ft. long and 8 in. wide?

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28. How many yards of oilcloth, 1 yard in width, will it take to cover a floor 18 ft. long and 15 ft. wide?

29. What part of a cubic foot is the cube of  $\frac{2}{3}$  of a foot?

30. How many feet of lumber are there in 4 boards 14 ft. long and 15 in. wide?



31. What must be the width of a board 16 ft. long to contain 12 sq. ft.?

32. What must be the length of a pile of 4-foot wood, 4 ft. high that contains  $12\frac{1}{2}$  cords?

33. What will 250 ft. of lumber cost at \$15 a thousand?

34. What will 7 cwt. of hay cost at \$12 a ton?

35. Through how many degrees does the earth turn on its axis in 4 hr. 20 min.? in 6 hr.? in 8 hr. 4 min.?

36. What part of a barrel is  $3\frac{1}{2}$  gal.?

37. What will 5 qt. of wheat cost at 96 cents a bushel?

38. A market woman bought 5 qt. of strawberries which she sold at 4 cents a pint, thereby gaining  $\frac{1}{4}$  of the cost; what did the berries cost her?

39. A grocer bought eggs at the rate of 5 for 4 cents and sold them at the rate of 4 for 5 cents; what part of the cost of the eggs did he gain?

40. What part of the cost of a quantity of chestnuts, at \$2.56 a bu., will be gained by retailing at 10 cents a quart?

41. What is the value of 2 oz. 5 pwt. of gold at  $\$ \frac{1}{4}$  per pennyweight?

42. If 6 oz. 8 pwt. of gold be divided between two miners, A and B, so that A's portion is  $\frac{3}{8}$  of B's, how much gold will each have?

43. What will 1 pk. 3 qt. of berries bring at \$3.20 a bushel?

44. If 5 men can do a piece of work in 5 hr. 20 min., how long will it take 4 men to do it?

45. If a cubic foot of water weighs  $\frac{1}{4}$  cwt., what weight of water will a trough hold that is 6 ft. long, 2 ft. wide, and 1 ft. deep?

46. What part of 5 lb. 4 oz. is 2 lb. 4 oz., Avoir.? What part is it in Troy weight?

47. 4 lb. 6 oz., Avoir., is  $\frac{7}{10}$  of what number of pounds?
48. What number of pounds, Troy, is  $\frac{7}{10}$  of 9 lb. 4 oz.?
49. What number of pounds, Avoir., increased by  $\frac{1}{4}$  of itself equals 4 lb. 11 oz.?
50. How many pieces of matting each  $6\frac{3}{4}$  ft. long and 3 ft. 3 in. wide will it take to cover the floor of a room 13 ft. 4 in. long and 13 ft. wide?
51. How wide is a room 18 ft. long that requires 27 sq. yd. of carpet to cover the floor?
52. If it cost \$75 at \$1.25 cents per square yard to carpet a room 12 ft. in width, what is the length of the room?
53. How many times can a bucket, holding  $1\frac{1}{2}$  cu. ft. of water, be filled from a tank 6 ft. long, 5 ft. wide, and 4 ft. deep?
54. At \$3.50 a cord what will be the cost of a pile of 4-foot wood 36 ft. long and 6 ft. high?
55. How many acres in a field 100 rd. long and 30 rd. wide?

ANALYSIS.—In 160 sq. rd. there are 8 times 20 sq. rd. There will therefore be as many acres in any rectangular field as the product of the number of times that 20 is contained in one of the dimensions multiplied by the number of times that 8 is contained in the other. Thus,  $100 \div 20 = 5$ ;  $30 \div 8 = 3\frac{3}{4}$ ;  $5 \times 3\frac{3}{4} = 18\frac{3}{4}$  acres.

56. How many acres in a field 60 rd. long and 18 rd. wide?
57. How many board feet in an inch board 14 ft. long and 9 in. wide?

ANALYSIS.—In a board foot, or 144 sq. in., there are 12 times 12 sq. in. There will therefore be as many board feet in any rectangular inch board as the number of times that 12 is contained in the length, multiplied by the number of inches in the width. Thus,  $14 \div 12 = 1\frac{1}{3}$ ;  $9 \times 1\frac{1}{3} = 10\frac{1}{3}$  board feet.

58. How many board feet in an inch board 10 ft. long and 8 in. wide? in one 15 ft. long and 7 in. wide?

## LESSON LX.

## PERCENTAGE.

To Find the Percentage.—

1. What is  $\frac{3}{100}$  of \$500?

ANALYSIS.— $\frac{1}{100}$  of \$500 is \$5; and  $\frac{3}{100}$  of \$500 is 3 times \$5, or \$15.

2. What is  $\frac{5}{100}$  of \$700? of \$900? of \$1,000?  
 3. What is  $\frac{7}{100}$  of \$400? of \$600? of \$800?  
 4. What is  $\frac{8}{100}$  of \$25?

ANALYSIS.— $\frac{1}{100}$  of \$25 is 25 cents; and  $\frac{8}{100}$  of \$25 is 6 times 25 cents, or \$1.50.

5. What is  $\frac{4}{100}$  of \$30? of \$40? of \$50?  
 6. What is  $\frac{2}{100}$  of 20 barrels?

ANALYSIS.— $\frac{1}{100}$  of 20 barrels is  $\frac{2}{100}$  bbl., or  $\frac{1}{50}$  bbl. and  $\frac{2}{100}$  of 20 bbl. is 3 times  $\frac{1}{50}$  bbl., or  $\frac{3}{50}$  bbl.

7. What is  $\frac{7}{100}$  of 35? of 60? of 75? of 80?

A number found as a number of hundredths of a number is called *percentage*. Thus,  $\frac{3}{100}$  of 1,200 is 36. The result 36 having been found as a number of hundredths of 1,200 is therefore a percentage. In operations of percentage, instead of the word "hundredths," the expression "per cent." is commonly used. It signifies "*by the hundred*," and is denoted by the symbol %, called the *per cent. sign*. Thus,  $\frac{3}{100}$  is 3 per cent., written 3%, and called a *rate per cent.*

The number of which a number of hundredths is found is called the *base*. Thus, in the expression, "3% of 1,200," the base is 1,200, and .03 is the *rate*.

The rate is the *ratio* of the percentage to the base.

The base plus the percentage is called *amount*; and the base minus the percentage is called *difference*.

8. How many hundredths of a number is 5 per cent. of it? 8 per cent. of it? 10 per cent. of it?

9. What per cent. of a number is  $\frac{6}{100}$  of it?  $\frac{4}{100}$  of it?  $\frac{7}{100}$  of it?  $\frac{8}{100}$  of it?  $\frac{12}{100}$  of it?  $\frac{25}{100}$  of it?

10. What is the meaning,—

Of 3 per cent. of 800? *Answer.*—It means  $\frac{3}{100}$  of \$800.

Of 5% of \$300? of 10% of 700 lb.? of 15% of 600 bu.?

11. How many hundredths in  $\frac{1}{2}$  of anything? in  $\frac{1}{3}$  of it? in  $\frac{1}{4}$  of it? in  $\frac{1}{5}$  of it? in  $\frac{1}{10}$  of it?

12. What per cent. of anything is  $\frac{1}{2}$  of it?  $\frac{2}{3}$  of it?  $\frac{3}{4}$  of it?  $\frac{2}{5}$  of it?  $\frac{4}{5}$  of it?  $\frac{3}{10}$  of it?  $\frac{7}{10}$  of it?  $\frac{8}{25}$  of it?

13. 40% of a number equals what fraction of it, in lowest terms? *Answer.*— $40\% = \frac{40}{100} = \frac{2}{5}$ .

The same question in the following:—

30%; 35%; 10%;  $12\frac{1}{2}\%$ ; 25%; 20%;  $33\frac{1}{3}\%$ ; 50%;  
75%;  $62\frac{1}{2}\%$ ;  $37\frac{1}{2}\%$ ;  $87\frac{1}{2}\%$ ?

These fractions are important, and ought to be committed to memory.

What is,—

14. 10% of 40?

20% of 35?

25% of 20?

15. 50% of 19?

$12\frac{1}{2}\%$  of 24?

$33\frac{1}{3}\%$  of 30?

16. 40% of 25?

5% of 60?

75% of 28?

17.  $37\frac{1}{2}\%$  of 32?

$62\frac{1}{2}\%$  of 36?

$87\frac{1}{2}\%$  of 48?

18. A farmer raised 70 bushels of potatoes of which he kept 20% for his own use; how many bushels did he keep?

19. A merchant bought some cloth for 60 cents a yard, and sold it at a gain of 25% on the cost; how many cents did he gain per yard?

20. Having \$24, I spent 50% of it for a suit of clothes; how many dollars did I pay for the suit?

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21. Henry bought a sled for 75 cents, and after using it a while, he sold it for  $33\frac{1}{3}\%$  less than he gave for it; how many cents did he receive for the sled?

22. Willie bought a sled for 75 cents and sold it for 20% more than he gave for it; how many cents did the sled bring him?

23. A man gained 15% on an investment of \$60; how many dollars did he gain?

SUGGESTION.— $15\% = \frac{15}{100} = \frac{3}{20}$ .

24. A man lost 28% on an investment of \$75; how many dollars did he lose?

SUGGESTION.— $28\% = \frac{28}{100} = \frac{7}{25}$ .

25. Wheat that was worth 80 cents a bushel has advanced 10%; what is the present price?

26. The catalogue price of a book is 56 cents. If a discount of  $12\frac{1}{2}\%$  of the catalogue price is allowed a purchaser, what will the book cost him?

27. What would be the cost of a book catalogued at 75 cents, and sold at a discount of 16% of the catalogue price?

28. A man's taxes are \$40; but on account of delay in payment he is charged 5% additional; how many dollars then does he have to pay?

29. Bought a bill of goods amounting to \$25 on which I am offered thirty days' time or a discount of 4% for present payment. If I accept the latter offer, what is the net cash cost of the goods?

30. A merchant marks his goods at an advance of 20% of the cost; how should a pair of shoes be marked that cost \$2.50?

31. A laborer who was receiving \$1.20 a day, had his wages increased 15%; what did he then receive per day?

32. A grocer put 200 barrels of apples in his cellar, of which 9% were lost by decay; how many barrels did he lose? *Answer.—He lost  $\frac{9}{100}$  of 200 barrels, or 18 barrels.*

33. A man paid \$500 for a piece of property and sold it, gaining 13% of the cost; how many dollars did he gain?

34. What is 7% of 150 dollars?

35. Mary is 16 years old, and Sarah's age is  $87\frac{1}{2}\%$  of Mary's; how old is Sarah?

36. From a bin of 50 bushels of wheat, it was estimated that 3% was consumed by rats; how many bushels did the rats get?

37. A merchant bought 10 barrels of flour for \$50, and sold it so as to gain 20% of the cost; what did he receive per barrel?

38. A paid \$100 for a horse, and sold it to B so as to gain 10% of the cost. B sold the horse to C at a loss of 10% of what B paid for it. What did C pay for the horse?

39. 8% of 300 is  $\frac{8}{100}$  of what number?

40.  $12\frac{1}{2}\%$  of 80 is 5% of what number?

41. What part of the cost is the gain at  $8\frac{1}{3}\%$ ? at 10%? at  $12\frac{1}{2}\%$ ? at 15%? at  $16\frac{2}{3}\%$ ?

42. 10% of \$25 is  $\frac{1}{5}$  of what Susan paid for a hat; what was the price of the hat?

43.  $62\frac{1}{2}\%$  of 24 days is  $\frac{3}{8}$  of how many days?

## LESSON LXII.

**To Find the Rate.—**

1. How many hundredths of \$50 is \$5?

ANALYSIS.—\$5 is  $\frac{1}{10}$  of \$50 or  $\frac{1}{100}$  of \$50.

2. How many hundredths of 25 is 4?
3. How many hundredths of 30 lb. is 12 lb.?
4. What per cent. of 64 is 8?

ANALYSIS.—8 is  $\frac{1}{8}$  of 64 or  $\frac{1}{100}$  of 64, which may be written 12½% of 64.

5. What per cent. of 40 is 12?

ANALYSIS.— $\frac{1}{10}$  of 40 is  $\frac{4}{10}$  or  $\frac{2}{5}$ ; 12 is as many hundredths of 40 as  $\frac{2}{5}$  is contained times in 12 or  $\frac{3}{10}$  of 40, or 30% of 40.

6. What per cent. of 30 is 6? is 5? is 15?
7. What per cent. of 28 days is 7 days?
8. What per cent. of 60 bu. is 9 bu.?
9. What per cent. of  $37\frac{1}{2}$  is 3? is 25?
10. What per cent. of 75 acres is  $5\frac{1}{4}$  acres?
11. A man paid \$70 for a horse and sold him for \$14 more than he gave; what per cent. did he gain?
12. From a flock of 60 sheep, 27 were sold; what per cent. of the flock was sold? What per cent. remained?
13. In a school of 56 pupils, 21 were boys; what per cent. were girls?
14. In an investment of 45 cents in pencils, a boy gained 27 cents; what was the gain per cent.?
15. Bought a horse for \$75, and sold it for \$66; what was the loss per cent.?
16. A merchant bought flour for  $\$6\frac{1}{2}$  a barrel, and sold it for  $\$8\frac{1}{2}$  a barrel; what per cent. did he gain?

17. Bought potatoes at 50 cents a bushel, and sold them at 18 cents a peck; what was the rate per cent. of gain?

18. A man having 65 miles to travel, walks at the rate of 4 miles an hour; what per cent. of his journey will he complete in  $6\frac{1}{2}$  hours?

19. What per cent. of 3 gallons is 3 pints?

20. What per cent. of  $\frac{1}{2}$  is  $\frac{1}{12}$ ?

21.  $\$3\frac{1}{2}$  is what per cent. of  $\$35$ ?

22. From a cistern holding 60 barrels of water,  $4\frac{1}{2}$  barrels were drawn per week; what per cent. of a cistern full of water was drawn each week?

23. 3 dimes is what per cent. of  $\$2\frac{1}{2}$ ?

24. 24 quarts is what per cent. of 5 bushels?

25. A grocer bought eggs at the rate of 6 eggs for 5 cents, and sold at the rate of 5 eggs for 6 cents; what rate per cent. did he gain?

## LESSON LXIII.

### To Find the Base.—

1. 18 is 9% of what number?

ANALYSIS.—Since 18 is 9% or  $\frac{9}{100}$  of the required number,  $\frac{1}{100}$  of that number is  $\frac{1}{9}$  of 18 or 2. Since 2 is  $\frac{1}{100}$  of the required number, that number is 100 times 2 or 200.

2. 20 is 5% of what number?

SUGGESTION.—20 is  $\frac{1}{100}$  or  $\frac{1}{10}$  of the required number.

3.  $\$48$  is 16% of what number of dollars?

4. 50 miles is 20% of how many miles?

5. 60 days is 12% of how many days?

6. 30 acres is 40% of how many acres?

7. 15 is  $12\frac{1}{2}$ % of what number?

Answer.—15 is  $12\frac{1}{2}$ % of 8 times 15 or 120.



8. 25 feet is  $33\frac{1}{3}\%$  of how many feet?
9. \$36 is  $37\frac{1}{2}\%$  of how many dollars?
10. 24 is 30% of what number?

*Answer.*—24 is 30% of  $\frac{1}{3}$  of 24 or 80.

11. 42 is 7% of what number?
12. 17 is 25% of what number?
13. By selling a horse at a gain of 20%, I make \$18 on the cost; what was the cost?
14. A farmer sold 36 sheep which was 75% of his flock; how many sheep were there in the flock?
15. John had 50 cents which was  $62\frac{1}{2}\%$  of the number his brother Henry had; how much money had Henry?
16. A man paid \$45 for a wagon which was 60% of what he paid for a horse; what was the cost of the horse?
17. George gained \$3 by selling his wheel at 5% advance on the cost; what did he receive for the wheel?
18. A farmer sold 18 acres which was 45% of his farm; how many acres were there in the farm?
19.  $\frac{1}{4}$  of 20 is 8% of how many times 40?
20. 8% of 500 is 10% of what number?
21. 10% of 500 is 8% of what number?

## LESSON LXIV.

1. A bookseller sold a book for 88 cents, thereby gaining 10% of the cost; what was the cost?

*ANALYSIS.*—The gain was  $\frac{1}{10}$  or  $\frac{1}{10}$  of the cost. The cost which may be called  $\frac{1}{1}$  plus the gain equals  $\frac{1}{1}$  or the selling price. Thus the cost is  $\frac{1}{1}$  of the selling price.  $\frac{1}{1}$  of 88 cents is 80 cents, or the cost of the book.

2. A horse was sold for \$85 which was 15% less than cost. Required the cost of the horse.

ANALYSIS.—The loss was  $\frac{15}{100}$  or  $\frac{3}{20}$  of the cost. The cost  $\frac{3}{20}$  less the loss equals  $\frac{17}{20}$  or the selling price. The cost is thus  $\frac{20}{17}$  of the selling price.  $\frac{20}{17}$  of \$85 is \$100 or the cost of the horse.

3. What number increased by 15% of itself equals 92?
4. What number diminished by 20% of itself equals 40?
5. A piece of cloth after shrinking  $12\frac{1}{2}\%$  of its length was 56 yards long; how long was it before shrinking?

*Answer.*—The original length was  $\frac{4}{3}$  of 56 yards, or 64 yards.

6. If a merchant makes 25% by selling cloth at 30 cents a yard, what was the cost of the cloth per yard?

7. A clerk saves \$28 a month when his expenses are 30% of his salary. Required his monthly salary.

8. In a company of ladies and gentlemen, 35% of the number of persons are gentlemen and 39 are ladies; how many persons are there in the company?

9. George sold a sled for 80 cents which was  $33\frac{1}{3}\%$  more than he gave for it; what did the sled cost him?

10. A grocer sold some flour at \$9 a barrel, thereby gaining 20%; what did the flour cost him per barrel?

11. A drover having sold 40% of a lot of cattle, had 57 head remaining; how many head were there in the lot?

12. What is the cost of tea on which a profit of 16% is made by selling at 57 cents a pound?

13. A man paid \$96 for a horse and wagon, paying 40% more for the horse than for the wagon; what did he pay for each?

14. John sold a knife for 50 cents, losing  $37\frac{1}{2}\%$  of the cost; what did the knife cost?

15. What was the cost of sugar on which a grocer made 20% by selling at 6 cents a pound?

16. Two men together have 65 acres of land, and one of them has  $62\frac{1}{2}\%$  as many acres as the other; how many acres has each?

17. A man bought 2 cows at the same price. He sold them gaining 30% on one, and losing 10% on the other. He receives for both \$88; what was the price of the cows?

18. A boy sold a pair of skates for 68 cents, losing 15% of the cost; for what sum should he have sold to gain 20%?

19. What number increased by 8% of itself equals  $32\frac{2}{3}$ ?

20. A piece of goods was marked to sell at a profit of 25%. The goods were sold at 75 cents a yard, which was  $16\frac{2}{3}\%$  the marked price; what did the goods cost per yard? What rate per cent. profit was made on the goods?

## LESSON LXV.

### MISCELLANEOUS PROBLEMS.

1. What is  $\frac{1}{2}$  of one per cent. of 50 dollars?

ANALYSIS. —  $\frac{1}{100}$  of 50 dollars is  $\frac{1}{2}$  dollar;  $\frac{1}{2}$  of  $\frac{1}{100}$  of 50 dollars is  $\frac{1}{4}$  of  $\frac{1}{2}$  dollar, or  $\frac{1}{4}$  dollar.

2. What is  $\frac{1}{2}\%$  of \$60? of \$75? of 20 days?
3. What is  $\frac{3}{4}\%$  of \$25? of \$30? of \$75?
4. What is  $\frac{5}{8}\%$  of \$20? of \$15? of \$80?
5. 5 per cent. of 60 is what per cent. of 40?
6. 8% of 50 is what per cent. of 60?
7. 10% of 25 is what per cent. of 30?
8.  $\frac{3}{8}$  is what per cent. of 10? of 6? of  $4\frac{1}{2}$ ? of 4?
9.  $\frac{5}{8}$  is what per cent. of  $10\frac{5}{12}$ ? of  $4\frac{1}{4}$ ? of  $3\frac{1}{3}$ ? of  $2\frac{1}{4}$ ?

10.  $\frac{7}{8}$  is what per cent. of  $2\frac{1}{2}$ ? of  $2\frac{3}{8}$ ? of  $1\frac{3}{4}$ ? of  $1\frac{5}{8}$ ?

NOTE.—The rate per cent. is the value of a fraction of which the percentage is the numerator, and the base is the denominator.

11. A merchant pays an agent  $\frac{7}{8}\%$  for collecting bills; what will the agent receive for collecting \$72?

The percentage paid an agent for buying, selling, or collecting is called *commission*.

12. An agent sells a gentleman's horse for \$150; what is the commission at  $\frac{4}{5}\%$ ?

13. What is the commission on \$80 at  $1\frac{1}{2}\%$ ?

14. An agent collects taxes on a commission of  $1\%$ ; what would be his commission for collecting A's taxes which amount to \$50?

15. A man pays an agent  $\frac{3}{4}\%$  for insuring his house to the amount of \$600; what does the insurance cost him?

Money paid for insurance is called *premium*.

16. What will be the premium for insuring a store for \$1,000 at one half of  $1\%$ ? at  $\frac{3}{4}\%$ ? at  $\frac{7}{8}\%$ ?

17. What will be the premium for insuring a house to the amount of \$500 at  $1\frac{3}{4}\%$ ?

18. What will it cost to insure a piano valued at \$400, at  $1\%$ ? at  $\frac{1}{2}\%$ ? at  $\frac{4}{5}\%$ ?

19. A commission agent received \$7 $\frac{1}{2}$  for purchasing \$1,000 worth of goods; what was his rate of commission?

20. Paid \$12 for insuring my library for \$750; what rate per cent. did I pay?

21. What is  $\frac{2}{5}\%$  of  $\frac{5}{8}$ ? of \$15? of \$25?

22. What rate per cent. profit does a merchant make who buys cloth at 40 cents a yard and sells it at 46 cents?

23. At what price must a clothier buy suits upon which he can make  $20\%$  profit by selling at \$18?

24. \$25 is  $6\frac{1}{4}\%$  of what number?
25. What must have been the cost of a book on which a bookseller lost 30% by selling it for 35 cents?
26. A merchant sold some cloth for 63 cents a yard at a loss of 16% on cost; what would he lose on 10 yards?
27. Two boys together weigh 148 pounds, and the weight of one is 85% of the weight of the other; what is the weight of each?
28. Mary's age is 70% of Sarah's, and the sum of their ages is 34 years; how old is each?
29. If I buy 15 barrels of apples for \$30, at how much per barrel must I sell them to gain 60%?
30. If an agent charges  $\$1\frac{1}{2}$  for collecting \$60, what rate per cent. does he charge?
31. What rate per cent. do I make by buying butter at  $\frac{3}{4}$  of the market price, and selling it at 5% above the market price.
32. A book retails at \$.70 which is 40% above the wholesale price; what was the wholesale price of the book?
33. A cask contained 60.1 gallons after having leaked  $3\frac{1}{3}\%$  of its contents; how many gallons were in the cask before any leaked out?
34. A gentleman gained \$60 by selling a village lot at  $12\frac{1}{2}\%$  above cost; what did the lot cost him?
35. A grocer sold 5 barrels of flour for \$48, gaining 20%; what was the cost of the flour per barrel?
36. A farmer sold two kinds of oats, altogether 110 bushels. There were 20% more of the better than of the poorer kind; how many bushels were there of each kind?
37. The farmer of the last problem, received \$41.50 for his oats at a price  $12\frac{1}{2}\%$  lower for the poorer kind than for the better; what price did he receive for each kind?

## LESSON LXVI.

## INTEREST.

**To Find the Interest. —**

1. A borrowed of B \$200, agreeing to pay him 6% for the use of the money for one year; how many dollars should A pay?

Money paid for the use of money is called *interest*; and money for use of which interest is paid is called *principal*. The sum of principal and interest is called *amount*.

Interest is reckoned as a percentage of the principal according to the time the money is used.

2. What is the interest of \$300 for one year at 7%? at 6%? at 5%? at 8%? at 9%?

3. What is the interest of \$250 for one year at 4%?

ANALYSIS. —  $\frac{1}{100}$  of \$250 is \$2½, and  $\frac{4}{100}$  of \$250 is 4 times \$2½ or \$10.

What is the interest for one year, —

4. Of \$320 at 5%? SUGGESTION: —  $5\% = \frac{5}{100} = \frac{1}{20}$ .

5. Of \$225 at 8%? 8. Of \$275 at 4%?

6. Of \$150 at 6%? 9. Of \$240 at 5%?

7. Of \$80 at 12½%? 10. Of \$65 at 10%?

11. What is the interest of \$200 for 2 years at 7%?

12. What is the interest of \$50 for 3 years at 6%?

13. What is the interest of \$100 for 2½ years at 8%?

What fraction of a year is 2 months? 3 months?  
4 months? 5 months? 6 months?

What is the interest, —

14. Of \$150 for 2 years 3 months at 6%?

15. Of \$200 for 1 year 6 months at 9%?

17. Of \$125 for 3 years 4 months at 4%?
18. Of \$30 for 2 years 8 months at 5%?
19. Of \$120 for 1 year 6 months at 6%?
20. Of \$300 for 2 years 9 months at 8%?
21. Of \$90 for 3 years 4 months at 10%?
22. Of \$80 for 2 years 3 months at  $12\frac{1}{2}\%$ ?
23. Of \$100 for 4 years 6 months at 7%?
24. Of \$150 for 3 years 2 months at 4%?
25. Of \$240 for 2 years 7 months at 5%?

In reckoning interest, a month is considered as consisting of 30 days.

26. What fraction of a month is 2 days? 3 days? 4 days? 5 days? 6 days? 10 days?

27. Reduce 3 months 12 days to a fraction of a year.

SOLUTION.—3 months 12 days is  $3\frac{2}{3}$  months or  $\frac{11}{4}$  months;  $\frac{11}{4}$  months is  $\frac{11}{12}$  of a year.

28. What is the interest of \$500 for 2 months 12 days at 8%?

29. What is the interest of \$400 for 2 years 1 month 15 days at 6%?

What is the interest,—

30. Of \$50 for 2 years 7 months 6 days at 4%?
31. Of \$200 for 1 year 3 months 18 days at 10%?
32. Of \$100 for 2 years 4 months 15 days at 8%?
33. Of \$300 for 1 year 4 months 24 days at 5%?
34. Of \$500 for 2 years 1 month 6 days at 6%?
35. Of \$400 for 9 months 18 days at 5%?
36. What is the amount of \$50 for 2 years at 7%?

ANALYSIS.—The interest of \$50 for 1 year at 7% is \$3 $\frac{1}{2}$ , and for 2 years it is \$7. The amount of \$50 for 2 years is \$50 plus \$7 or \$57.

What is the amount,—

37. Of \$100 for 2 years 4 months at 6%?

38. Of \$200 for 1 year 4 months 24 days at 5%?

SUGGESTION.—24 days is  $\frac{1}{5}$  of a month; 4 months 24 days is  $4\frac{1}{5}$  months, or  $\frac{21}{5}$  months;  $\frac{1}{5}$  of  $\frac{21}{5}$  is  $\frac{21}{25}$ .

39. Of \$150 for 2 years 3 months 18 days at 4%?

40. Of \$50 for 1 year 2 months 12 days at 6%?

41. Of \$200 for 2 years 6 months 20 days at 9%?

42. Of \$100 for 1 year 7 months 6 days at 5%?

43. Of \$72 for 3 years 1 month 10 days at  $12\frac{1}{2}$ %?

44. Of \$40 for 10 months 24 days at 10%?

45. Of \$300 for 2 years 5 months 10 days at 6%?

46. Of \$300 for 6 months 12 days at 5%?

## LESSON LXVII.

To Find the Rate.—

If I receive \$9 for the use of \$60 for 2 years, what rate per cent. interest do I get for the use of my money?

ANALYSIS.—\$9 interest in 2 years is  $\frac{9}{2}$  per year.  $\frac{9}{2}$  interest for \$60 is  $\frac{3}{4}$ , or  $\frac{3}{2}$  for \$10.  $\frac{3}{2}$  for \$10 is  $3\frac{1}{2}$  or  $3\frac{1}{2}$  for \$100.  $3\frac{1}{2}$  for \$100 is  $7\frac{1}{2}$ %.

48. The interest of \$75 for 4 years is \$18; what is the rate per cent.?

ANALYSIS.—The interest for 4 years is  $\frac{18}{4}$  or  $\frac{9}{2}$  of the principal. For 1 year it is  $\frac{1}{4}$  of  $\frac{9}{2}$  or  $\frac{9}{8}$  of the principal; and  $\frac{9}{8}$  is 6%.

49. The interest of \$40 for 3 years is \$6; what is the rate per cent.?

50. The interest of \$85 for  $2\frac{1}{2}$  years is \$17; what is the rate per cent.?

51. The interest of \$50 for 3 years 4 months is \$10; what is the rate per cent.?



At what rate per cent. will,—

52. \$35 gain \$7 in 2 years 6 months?
53. \$80 gain \$18 in 2 years 3 months?
54. \$150 gain \$30 in 3 years 4 months?
55. \$200 gain \$12 in 1 year 2 months?
56. \$120 gain \$12 in 1 year 8 months?
57. \$250 gain \$35 in 3 years 6 months?
58. \$300 gain \$49 in 2 years 4 months?
59. \$400 gain \$21 in 1 year 9 months?
60. \$50 gain \$8 in 2 years 8 months?
61. At what rate per cent. will \$200 gain \$54 in 3 yr. 4 mo. 15 da.?

ANALYSIS.—4 mo. 15 da. is  $4\frac{1}{4}$  mo. or  $\frac{1}{3}$  mo. =  $\frac{1}{3}$  yr.; 3 yr. plus  $\frac{1}{3}$  yr. =  $3\frac{1}{3}$  yr. or  $3\frac{1}{4}$  yr.;  $\$54 \div 3\frac{1}{4} = \$16$ . The interest for one year being  $\frac{1}{10}$  or  $\frac{1}{10}$  of the principal, the rate is 8%.

62. At what rate per cent. will \$80 gain \$19 in 2 years 4 months 15 days?
63. If the interest of \$150 for 1 year 3 months 20 days is \$24, what is the rate per cent.?
64. The principal being \$200, the interest \$54, and the time 3 yr. 4 mo. 15 da.; what is the rate per cent.?
65. Given the principal \$106, the interest \$15 $\frac{1}{2}$ , and the time 2 yr. 2 mo. 12 da., to find the rate per cent.
66. Given the principal \$120, the interest \$9 $\frac{3}{4}$ , and the time 1 yr. 7 mo. 6 da., to find the rate per cent.

SUGGESTION.—7 mo. 6 da. is  $7\frac{1}{2}$  or  $\frac{3}{4}$  mo. =  $\frac{1}{4}$  yr.

67. Given the principal \$250, the interest \$28, and the time 2 yr. 9 mo. 18 da., to find the rate per cent.
68. Given the principal \$90, the interest \$10, and the time 1 yr. 1 mo. 10 da., to find the rate per cent.
69. Given the principal \$200, the interest \$35, and the time 2 yr. 6 mo., to find the rate per cent.

## LESSON LXVIII.

**To Find the Principal.—**

70. What principal at 6% for 5 years will give \$12 interest?

ANALYSIS.—To give \$12 interest in one year at 6% would require \$200 principal; to give the same interest in 5 years would require  $\frac{1}{5}$  of \$200, or \$40.

What principal will give,—

71. \$14 interest at 7% in 4 years?

72. \$10 interest at 8% in 2 years?

73. \$12 interest at 5% in 3 years?

74. \$36 interest at 6% in 4 years?

75. \$40 interest at 4% in 5 years?

76. \$42 interest at 3% in  $3\frac{1}{2}$  years?

77. What principal at  $5\frac{1}{2}$ % for 2 years will give \$13 $\frac{1}{2}$  interest?

ANALYSIS.—If the principal was \$100, the interest at  $5\frac{1}{2}$ % for 2 years would be \$11. Now \$13 $\frac{1}{2}$ , or  $\frac{25}{2}$ , is  $\frac{5}{2}$  of 11; hence the required principal is  $\frac{5}{2}$  of \$100, or \$120.

78. What principal at 6% for 3 years 4 months will give \$50 interest? \$60 interest?

79. What principal at 4% for 2 yr. 3 mo. will give \$18 interest? \$45 interest?

80. What principal at 8% for 2 yr. 6 mo. will give \$30 interest? \$35? \$40? \$50? \$75?

81. A man borrowed a sum of money upon which the interest at 7% annually for 3 yr. 2 mo. 12 da. was \$56. Required the sum borrowed.

82. What sum will amount to \$72 in 4 years at 5%?

ANALYSIS.—The interest of \$100 for 4 years at 5% is \$20; the amount is \$120; the principal is  $\frac{1}{3}$  of the amount; and  $\frac{2}{3}$  of \$72 is \$60.

83. What principal placed at interest for  $2\frac{1}{2}$  years at 4% will amount to \$55?

84. What principal placed at interest for 3 yr. 4 mo. at 6% will amount to \$60? to \$72?

ANALYSIS.—The interest of \$1 for 1 year is  $\frac{1}{20}$ , and for 3 yr. 4 mo. or  $3\frac{1}{2}$  years it will be  $\frac{1}{2}$  times  $\frac{1}{20}$ , or  $\frac{1}{4}$ ; the amount is  $1\frac{1}{4}$  or  $\frac{5}{4}$ ; the principal \$1, or  $\frac{4}{5}$ , is  $\frac{4}{5}$  of the amount, and  $\frac{4}{5}$  of \$60 is \$50.

85. What principal will amount to \$90 in 4 years at 5%?

86. What principal will amount to \$91 in 5 years at 8%?

A principal which will amount to a given sum in a given time at a given rate per cent. is called the *present worth* of that sum.

The amount less the present worth is called *discount*. The discount is the interest on the present worth for the given time and rate. This discount is called *true discount*.

87. What is the present worth of \$66 due 5 years hence, at 4%? What is the discount?

88. What is the present worth of \$45 due 2 yr. 6 mo. hence at 5%? What is the discount?

SUGGESTION.—Assume \$10 as a principal, whence the interest at 5% for  $2\frac{1}{2}$  years is \$1 $\frac{1}{4}$  and the amount, \$11 $\frac{1}{4}$ .

89. What are the present worth and discount of \$60 due 3 yr. 4 mo. hence at 6%?

90. What are the present worth and discount of \$63 due in 5 years at 8%?

ANALYSIS.—Assuming \$10 as a principal,  $\frac{1}{10}$  or  $\frac{1}{10}$  of \$10 is  $\frac{1}{10}$ , the interest for one year; the interest for 5 years is 5 times

$\$4$  or  $\$4$ ; the amount is  $\$10 + \$4$  or  $\$14$ ; the interest is  $\frac{1}{4}$  or  $\frac{1}{4}$  of the amount;  $\frac{1}{4}$  of  $\$63$  is  $\$18$  which is the discount; the present worth is  $\$63$  less  $\$18$ , or  $\$45$ .

91. At the expiration of 4 years from the present time, A is to pay B  $\$236$  including principal and interest; what sum should B accept as a present payment, money being worth  $4\frac{1}{2}$  per cent.?

## LESSON LXIX.

To Find the Time.—

92. In what time will  $\$60$  at 5% give  $\$12$  interest?

ANALYSIS.— $\$60$  at 5% will give  $\$3$  interest in one year. It will therefore take as many years for  $\$60$  to give  $\$12$  interest as  $\$3$  is contained times in  $\$12$ , or 4 years.

93. In what time will  $\$75$  at 6% give  $\$9$  interest?

94. In what time will  $\$80$  at 7% give  $\$28$  interest?

95. In how many years will  $\$100$  at 8% give  $\$17$  interest?

96. In how many years, months, and days will the interest of  $\$150$  at 6% be  $\$13$ ?

97. In what time will a sum of money double itself at 4%? at 5%? at 6%? at  $12\frac{1}{2}\%$ ?

98. In what time will a sum of money treble itself at 5%? at 8%? at 10%?

99. In what time will  $\$40$  amount to  $\$50$  at 5% interest?

100. In what time will  $\$75$  amount to  $\$90$  at 6% interest?

101. When interest was 6%, A let B have the use of  $\$50$  for a year; for what length of time should B let A have the use of  $\$75$  when the interest is 5%, to balance the favor?

102. For what time is the interest of  $\$60$  at 5%, the same as the interest of  $\$50$  for 2 years at 7%?

103. The amount of a certain principal at 8% is \$56, and for the same time at 10% it is \$60; what are the principal and the time?

104. In what time is the amount of \$96 at  $12\frac{1}{2}\%$  the same as the amount of \$100 at 6% for 4 months?

105. In what time is interest at 7% equal to the principal?

106. In what time will  $\frac{1}{2}$  at 5% amount to \$1?

107. The discount of \$93 at 6% is \$18; what is the time?

108. A clock gains  $1\frac{1}{2}\%$ ; in what time will it gain an hour?

109. One of two clocks loses  $\frac{1}{4}\%$  and the other  $\frac{1}{2}\%$ ; if they are set together, in what time will they be 15 minutes apart?

110. A and B are 5 miles apart and are traveling in the same direction. If A gains 20%, how far must each travel for A to overtake B? If B travels 4 miles an hour, in what time will he be overtaken?

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## LESSON LXX.

### BANK DISCOUNT.

1. What is the bank discount of \$50 for 60 days at 6%?

SOLUTION.—The time is 60 days + 3 days of grace, or 63 days. The interest of \$50 for 60 days, or  $\frac{1}{2}$  of a year, at 6% is  $\frac{1}{2}$  of  $\frac{1}{10}$  of \$50, or 50 cents. The interest for 3 days, or  $\frac{1}{20}$  of 60 days, is  $\frac{1}{20}$  of 50 cents, or  $2\frac{1}{2}$  cents; 50 cents +  $2\frac{1}{2}$  cents, or  $52\frac{1}{2}$  cents, is the bank discount sought.

2. What is the bank discount of \$60 for 60 days at 6%?

*Answer.*—60 cents +  $\frac{1}{20}$  of 60 cents.

3. What is the bank discount of \$80 for 60 days at 6%?

4. What is the bank discount of \$100 for 60 days at 6%?

5. What is the bank discount of \$75 for 60 days at 6%?

6. What is the bank discount of \$40 for 90 days at 6%?

SOLUTION.—

The bank discount of \$40 for 60 days at 6% is 40 cents.

“ “ “ “ \$40 “ 30 “ “ 6% “ 20 “

“ “ “ “ \$40 “ 3 “ “ 6% “ 2 “

“ “ “ “ \$40 “ 93 “ “ 6% “ 62 cents.

7. What is the bank discount of \$100 for 90 days at 7%?

SUGGESTION.—The bank discount of \$100 for 93 days at 6% is \$1 + 50 cents + 5 cents, or \$1.55. At 7% it is  $\$1.55 + \frac{1}{4}$  of \$1.55, or \$1.81.

8. What is the bank discount of \$60 for 90 days at 8%? *Answer.*—93 cents +  $\frac{1}{4}$  of 93 cents, or \$1.24.

9. What is the bank discount of \$75 for 30 days at 6%? at 8%? at 9%?

10. What is the bank discount of \$80 for 45 days at 6%? at 9%? at 10%?

What is the bank discount,—

11. Of \$90 for 40 days at 6%?

12. Of \$120 for 75 days at 8%?

13. Of \$150 for 90 days at 7%?

14. Of \$200 for 30 days at 6%?

15. Of \$300 for 45 days at 5%?

16. Of \$400 for 90 days at 9%?

Principles:—

1. The *base* in bank discount is the *amount*.

2. The *base* in true discount is the *present worth*.

3. The difference between true discount and bank discount is the interest on the true discount.

## LESSON LXXI.

## TRADE DISCOUNT.

1. A wholesale dealer's price for a piece of broadcloth is \$4 per yard, subject to a discount of 25% and 10%; what is the net cost of 10 yards?

ANALYSIS.—At \$4 a yard, 10 yards would cost 10 times \$4, or \$40; 25% or  $\frac{1}{4}$  of \$40 is \$10; \$40—\$10 is \$30, or net cost after first discount; 10%, or  $\frac{1}{10}$  of \$30, is \$3; \$30—\$3 is \$27, or net cost required.

Deductions made by wholesalers, jobbers, manufacturers, publishers, and others, from the catalogue or list price of goods are called *trade discounts*.

2. What is the net price of a book listed at \$1, and sold at a discount of 20% and  $12\frac{1}{2}\%$ ?

3. Sold hats listed at \$48 a dozen at discounts of 20%,  $16\frac{2}{3}\%$ , and  $12\frac{1}{2}\%$ ; what was the net selling price?

What is the net selling price,—

4. Of goods listed at \$50 subject to 20% and 10% discounts?

5. Of goods listed at \$60,  $\frac{1}{4}$  and  $\frac{1}{8}$  off?

6. Of goods listed at \$75,  $\frac{1}{8}$  and  $\frac{1}{10}$  off?

7. Of books listed at \$2,  $\frac{1}{8}$ ,  $\frac{1}{10}$ , and  $\frac{1}{10}$  off?

8. Of bookcases listed at \$40,  $\frac{1}{4}$  and  $\frac{1}{10}$  off?

9. The net cost of a bill of goods, after discounts of  $12\frac{1}{2}\%$  and 10% was \$63; what was the list cost?

SUGGESTION — \$63 is  $\frac{7}{8}$  of  $\frac{9}{10}$  of list cost.

10. Given net cost \$60 and discounts 20% and  $16\frac{2}{3}\%$  to find list cost.

The per cent. that the net cost is of the list or gross cost is called the *net cost rate*; and the per cent. that the whole discount is of the list cost is called the *net discount rate*. For two discounts, the net discount rate is the sum of the two rates minus their product. Thus, in Ex. 10, above,  $\frac{1}{4} + \frac{1}{4} - \frac{1}{16} = \frac{1}{2}$ , or  $33\frac{1}{3}\%$ .

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## LESSON LXXII.

### MISCELLANEOUS PROBLEMS.

1. If a man traveling 12 hours a day can perform a journey in 8 days, in how many days could he perform the same journey traveling 16 hours a day?

2. After spending  $\frac{3}{5}$  of my money, I had \$70 left; how many dollars had I at first?

3. A man went  $\frac{1}{4}$  of a journey by train,  $\frac{5}{8}$  of the remainder by stage, and walked the last 3 miles; how long was the journey?

4. If it cost \$8.40 for oats to feed 2 horses 6 weeks, what will it cost to feed 3 horses 5 weeks?

5. Of three railroad engineers, A, B, and C, A makes 5 runs to B's 2, and B makes 3 runs to C's 4; how many runs do they each make in a total of 100 runs?

6. If 3 men can build 24 yards of wall in 4 days, how many yards can 7 men build in 5 days?

7. A and B do  $\frac{1}{4}$  of a piece of work in 6 days, B then finishes the work in 8 days more; how many days would each require to do the whole work alone?

8. How many yards of carpet 25 inches wide will be required for a room 22 ft. 6 in. long and 16 ft. 8 in. wide?



9. If a profit of 10% was made by selling sugar for  $5\frac{1}{2}$  cents a pound, what was the cost of the sugar per cwt.?

10. A grocer bought coffee at 40 cents a pound, and sold it for 45 cents a pound; what rate per cent. did he gain?

11. A grocer bought some berries at 8 cents a quart, and twice as many quarts at 5 cents. He mixed them and sold at 7 cents a quart; what rate per cent. did he gain?

12. Three sevenths of a body of choppers cut 2 cords of wood each in a day, and the rest,  $2\frac{1}{2}$  cords. Altogether they cut 288 cords in a week; how many choppers were there?

13. What rate per cent. profit is made by buying chickens at 50 cents each, and selling them at \$7 a dozen?

14. A merchant sold 25 yards of cloth for \$30 and thereby gained the cost of 5 yards; what rate per cent. was the profit?

15. What must be the length of a board 7 inches wide to contain  $5\frac{5}{8}$  sq. ft.

16. What must be the length of a field 15 rods wide to contain  $3\frac{1}{2}$  acres?

17. In how many years will \$12 at 10% amount to \$17.20?

18. At what rate per cent. will the interest of \$20 be \$2.75 in  $2\frac{1}{4}$  years?

19. If a tailor makes  $12\frac{1}{4}$  per cent. profit by selling a suit of clothes for \$27, what per cent. would he make by selling it for \$30?

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20. Ten men undertake to do a piece of work in 12 days. After working 9 days, it is discovered that only  $\frac{2}{3}$  of the work is completed; how many more men are required to complete the work within the allotted time?

21. An agent receives \$4 for selling a horse on a commission of  $2\frac{1}{2}$ %; at what price was the horse sold?

22. What per cent. is  $\frac{3}{4}$  of \$5? of 20 ct.? of 45 ct.?
23. I buy a book listed at \$5, at  $\frac{1}{3}$  and  $\frac{1}{3}$  off; required the net cost.
24. I pay \$12 for a set of Dickens's works listed at \$20; what is the net discount rate?
25. What is the list price of a set of books the net cost of which is \$20 and the discount  $\frac{1}{3}$  and  $\frac{1}{3}$ ?
26. What is the net proceeds, to the nearest cent, of \$64 discounted at bank for 90 days at 8%?

SOLUTION.—

Discount of \$64 for 60 days at 6% is 64 cents.

"	"	"	"	30	"	"	"	"	32	"
"	"	"	"	3	"	"	"	"	3	"
<hr/>										
"	"	"	"	93	"	"	"	"	99	"

For 8% add  $\frac{1}{3}$  of 99 cents 33

Discount is \$1.32.

Net proceeds is \$64 — \$1.32, or \$62.68.

ANOTHER SOLUTION.—For 8% add  $\frac{1}{3}$  of 93 days, or 31 days. 93 days + 31 days is 124 days, or  $2\frac{1}{3}$  times 60 days.  $2\frac{1}{3}$  times 64 cents is \$1.32. \$64 — \$1.32 is \$62.68.

27. What is the net proceeds of \$60 discounted at bank for 75 days at 7%?
28. What is the net proceeds of \$25 discounted at bank for 60 days at 9%?
29. What is the net proceeds of \$100 discounted at bank for 45 days at 8%?
30. What is the bank discount of \$50 for 30 days at 7%?
31. If a 2-cent loaf weigh 6 ounces when wheat is 75 cents a bushel, what ought a 4-cent loaf to weigh when wheat is worth \$1 a bushel?
32. If by selling cloth at 30 cents a yard, I lose 25%, what should I sell it at to gain 20%?

33. A dealer bought two horses at the same price. He sold one of them at a loss of 10% and the other at a gain of 25%. He received for the two horses \$18 more than he gave for them. At what price were the horses bought?

34. How many cubic yards of earth will be removed in excavating a cellar 24 ft. long, 16 ft. wide, and 9 ft. deep?

35. What will 1,250 lb. of hay cost at \$8 a ton?

36. A grocer bought a quantity of butter at 15 cents a pound, and sold it at \$16 a hundredweight; what rate per cent. did he gain?

37. A grocer bought butter at 16 cents a pound and sold it at a profit of  $12\frac{1}{2}\%$ ; what did he receive per cwt.?

38. A jobber paid 20 cents apiece for ax helves and listed them at \$4.50 a dozen,  $\frac{1}{5}$  and  $\frac{1}{5}$  off; what rate per cent. did he make?

39. Which is the better, to sell eggs at 9 cents a dozen or 80 cents a hundred? What per cent. better?

40. What will be the cost of 50 fence boards 16 feet long and 6 inches wide at \$8 a thousand?

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41. A man left home at 8 o'clock in the morning to walk to town and back. He spent an hour in town, and returned at 12 o'clock. Required the distance to town, the rate of walking being 4 miles an hour.

42. A purse and the money in it were worth \$5, and the worth of the purse was  $\frac{3}{17}$  of the worth of the money; what was the worth of the purse?

43. What number is the same per cent. of 15 that 2 is of 25?

44. What will a piece of land 32 rods long and 25 rods wide cost at \$20 an acre?

45. What is the interest of \$50 for 2 years at 7%?

46. What is the amount of \$75 for 1 yr. 4 mo. at 8%?

47. What principal will amount to \$84 in 2 years at 6%?

*Suggestion.*—Show that for \$100 principal, the amount is  $1\frac{1}{3}$  of the principal.

48. What principal at interest for 1 yr. 3 mo. at 10% will amount to \$90?

*Question.* The principal is what part of the amount?

49. What per cent. of \$16 is \$6?

50. Of 50 questions 4% were missed; how many questions were correctly answered?

51. A and B bought a cow for \$40, A paying \$5 for every \$3 paid by B. They sold the cow for \$60; how should the money be divided?

52. A, B, and C bought 72 bushels of potatoes at 50 cents a bushel. A paid  $\frac{1}{3}$  of the cost, B  $\frac{1}{4}$ , and C the remainder; how many bushels should each have?

53. Two men hired a pasture together for \$30. One pastured 7 cows and the other 8 cows; how many dollars should each pay?

54. What time should 24 men take to finish a piece of work of which 18 men have done one half in 9 days?

55. A can run 10 yards while B runs  $9\frac{1}{2}$  yards, and B can run 20 yards while C runs 19 yards; how many yards can C run while A runs 40 yards?

56. What gain per cent. is made by buying pears at 3 for 4 cents and selling them at 2 for 6 cents?

57. A man walking 20 miles finds that the distance he has walked in  $1\frac{1}{4}$  hours equals  $\frac{1}{3}$  of the remaining distance; what was his rate of walking?

58. A and B are 85 miles apart. If they start at the same time and travel toward each other, A at the rate of 4 miles an hour, and B at  $4\frac{1}{2}$  miles an hour; how far will each travel to the place of meeting?

59. On a certain railroad the telegraph posts are 10 rods apart. If a passenger counts 37 in 2 minutes, at what rate is the train moving?

60. A can do a piece of work in 5 days, and B in 8 days. If they do the work together for \$65, how should the money be divided?

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61. Mary is  $\frac{1}{2}$  as old as Sarah, but in 6 years she will be  $\frac{2}{3}$  as old. How old is each?

62. I pay \$12 for the insurance of my house at the rate of  $\frac{3}{4}$  of 1 per cent.; what was the amount of the insurance?

63. How many nickels, dimes, and quarters, an equal number of each, make \$6?

64. A grocer paid \$8 for berries at the rate of 50 cents for 8 quarts; how many bushels did he buy?

65. A and B hire a pasture for \$49. A put in 4 horses for 6 weeks and B, 5 horses for 5 weeks; how should the cost be divided?

66. What time of day is it when  $\frac{2}{3}$  of the time since noon equals  $\frac{1}{3}$  of the time to midnight?

67. In the division of some money between Charles and Henry,  $\frac{2}{3}$  of what Charles received was  $\frac{1}{4}$  of Henry's share; and Henry had \$1 more than Charles; how many dollars did each receive?

68. William does  $\frac{2}{3}$  of a piece of work in 4 hours, John does  $\frac{1}{3}$  of what remains in 1 hour, and James finishes the work in  $\frac{1}{2}$  of an hour; in what time could each do the whole work alone?

69. By selling tea at \$1.20 per pound, a grocer gains  $\frac{1}{4}$  of his outlay. What did the tea cost per pound?

70. I can walk to a certain place and ride back in  $5\frac{1}{2}$  hours. I can walk both ways in 7 hours; how long would it take to ride both ways?

71. What is the net cost and the net rate of discount on a bill of goods listed at \$5,  $\frac{1}{3}$  and  $\frac{1}{4}$  off?

72. From a company of persons 15 retire, when it was noticed that the number remaining lacked 5 persons of being  $\frac{3}{4}$  of the original company; how many persons were there at first?

73. A gentleman paid for a watch and chain at the rate of \$8 for the watch, to \$3 for the chain. Had the watch cost \$5 more than it did, he would have paid at the rate of \$3 for the watch to \$1 for the chain; what was the cost of each?

74. A man being asked the cost of a horse he had bought, answered, " $\frac{3}{4}$  of the cost and \$5 equals  $\frac{1}{4}$  of the cost;" what did the horse cost?

75. A man walked a certain distance in  $13\frac{1}{3}$  hours, going  $\frac{2}{3}$  of the distance plus 5 miles in 10 hours; what was the distance and also the rate of walking?

76. A grocer bought a lot of apples at 3 for 2 cents, and twice as many at 2 for 1 cent. He sold the lot at 6 for 5 cents; did he gain or lose and what per cent.?

77. A merchant sold  $\frac{1}{4}$  of a lot of goods at a loss of 10%; how must he sell the remainder to gain  $12\frac{1}{2}\%$  on the whole?

78. Two numbers are to each other as 1 to 2, but if 2 be subtracted from each, they will be to each other as 1 to 3; what are the numbers?

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79. In a school of 40 pupils there were  $\frac{3}{4}$  as many boys as girls. How many were there of each?

80. What must I charge for flour costing \$5 a barrel so that falling 25% I may still make 20%?

81. A man lost \$15 by selling a horse for 20% less than cost; what did the horse cost?

82. Sold a horse for \$175, gaining  $16\frac{2}{3}\%$  on cost; what did the horse cost?

83. An agent received \$260 to invest in goods after retaining 4% commission on the amount invested; what was the sum invested?

84. A merchant marked goods at 20% advance on cost, but sold at  $12\frac{1}{2}\%$  off from marked price; what was his gain per cent.?

85. What must I ask for hay costing \$10 a ton, in order that after falling 10% from the asked price, I may make 10% on cost?

86. A man being asked how many sheep he had, answered that if he had as many more,  $\frac{1}{2}$  as many more, and  $2\frac{1}{2}$  sheep, he should have 100; how many had he?

87. What number is it to which if its  $\frac{1}{2}$  and its  $\frac{1}{3}$  be added the sum will be 77?

88. If \$80 worth of provision will last 20 men 24 days, how many days will \$100 worth last 30 men?

89. A hare has 76 rods the start of a hound, but the hound runs 14 rods to 10 of the hare; how many rods must the hound run to overtake the hare?

90. If A can do a piece of work in 5 days and B can do the same work in 7 days, how many days would it take both to do it?

91. If to John's age its  $16\frac{2}{3}\%$  be added, the sum will be 21 years; how old is he?

92. Mary's money plus 25% of it equals \$75; how much money has she?

93. The entire cost in purchasing a carriage, commission 4%, was \$312; what was the net cost of the carriage?

94. An agent sold \$400 worth of goods and received \$15 commission; what was the rate per cent. commission?

95. A merchant paid \$200 annually for insuring his goods at  $1\frac{1}{2}\%$ ; what was the value of the goods?

96. What is the interest of \$400 for 2 yr. 4 mo. at  $7\%$ ?

97. What is the amount of \$150 for 2 yr. 8 mo. at  $6\%$ ?

98. At what rate per cent. will \$35 be the interest of \$200 for 3 yr. 6 mo.?

99. If gold is quoted at 115, how much currency will be equal in value to \$100 in gold?

100. When stock is quoted at 105, how much stock can be bought for \$315?

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101. How many acres are there in a square field 40 rods on a side?

102. How many acres are there in fields of the following dimensions:—

(1) 80 rods long and 24 rods wide?

(2) 64 rods long and 20 rods wide?

(3) 40 rods long and 36 rods wide?

(4) 32 rods long and 18 rods wide?

(5) 20 rods long and 14 rods wide?

103. How many feet of lumber are there in 10 2-inch planks 16 feet long and 9 inches wide?

104. What will 20 1-inch boards 15 feet long and 10 inches wide cost at \$12 a thousand?

105. The roof of a house is 30 feet long and the width of each side is 20 feet. What will the roof cost at \$3 per square of 100 sq. ft.?

106. How many yards of carpeting  $\frac{1}{4}$  yd. wide will it take to cover a floor 25 ft. long and 18 ft. wide?

107. What will be the cost of sawing a pile of wood 20 ft. long, 4 ft. wide, and 6 ft. high at \$1.20 per cord?



108. If 25% was lost by selling corn at 45 cents a bushel, what per cent. would have been lost by selling at 50 cents a bushel?

109. When stock worth \$3,000 at par sells for \$3,240, what is the rate per cent. premium?

110. Bought a yoke of oxen for \$90, paid \$35 for keeping, and sold them at a gain of \$15; what was the rate per cent. of profit on gross cost?

111. The list price of a buggy is \$80; what is the net price if a discount of 25% and 10% is allowed?

112. Books are bought at a discount of 20% from the list price. What is the gain per cent. by selling at the list price?

113. What single discount is equivalent to the following discounts:—

(1) 15% and 10%? (2) 20% and  $12\frac{1}{2}\%$ ? (3) 25%, 20%, and 10%?

114. A lawyer, collecting a note on a commission of 5% received \$6.25; what was the face of the note?

115. If I buy hats at \$27 a dozen, at what price apiece must I sell them to gain  $16\frac{2}{3}\%$ ?

116. A dealer bought 120 barrels of flour for \$600. If he sold at an advance of 20%, what was his profit per barrel?

117. A man bought 40 sheep, which was 25% of the number he already had; how many sheep may he now sell and have remaining 75% of his original flock?

118. A farmer sold 20% of his land to B, and 25% of the remainder to C. He then had 120 acres; how many acres had he at first?

119. A and B can do a piece of work in 12 days, and A can do  $\frac{2}{3}$  as much as B; in what time can each do the work alone?

120. If I retail at a gain of 25%, and sell at wholesale for 4% less than at retail, what is my gain per cent. at wholesale?

121. Of a barrel of vinegar 10% leaked away; what per cent. must I gain on the remainder that I may gain 10% on the whole?

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122. Bought land at \$30 an acre; how much must I ask an acre that I may abate 25% from my asking price and still make 20% on the cost?

123. A dealer adds 10% of water to the pure spirits he buys, and sells the mixture at a price 10% greater than the cost price of pure spirit; what was his profit per cent.?

124. There are 70 bushels of wheat in 2 bins, and in one bin there are 10 bushels less than  $\frac{2}{3}$  as many bushels as there are in the other; how many bushels are there in each bin?

125. The difference between  $12\frac{1}{2}\%$  of a number and  $16\frac{2}{3}\%$  of it is 8; what is the number?

126. A father gave his sons \$5 each and had \$30 remaining. Had he given them \$8 each, it would have taken all his money; required the number of sons and the amount of the father's money.

127. John bought a number of oranges at 5 cents each; had he bought the same number of peaches at 3 cents each, they would have cost 14 cents less; how many oranges did he buy?

128. A gentleman distributed 28 apples among an equal number of boys and girls, giving to each boy 4 apples, and to each girl 3 apples; how many boys were there?

129. A and B agree to do a piece of work for \$70; A receives \$2 a day for twice as many days as B receives \$3 a day; how many days did each work?

130. How far may a person ride in a coach which goes at the rate of 6 miles an hour so that he may be gone 5 hours, provided he walks back at the rate of 4 miles an hour?

131. If for every 4 cows a farmer keeps, he has to plow an acre and leave an acre of pasture for every 2 cows, how many cows could he keep on 15 acres?

132. A company of 15 persons engage a dinner, but before the bill was paid, 5 persons left by which each person's bill was increased  $\$ \frac{1}{3}$ ; what was the bill?

133. A can do 3 times as much work in a day as B, and B can do twice as much as C; in how many days can A do as much work as C can do in 4 days?

134. How shall \$50 be divided between A and B, so that A shall receive  $\$2\frac{1}{2}$  as many times as B receives  $\$3\frac{1}{2}$ ?

135. A said to B, "I have  $\frac{2}{3}$  as much money as you; if I had \$5 more than I have and you \$10 less, we should have equal sums;" how much money had each?

136. In a run of 176 yards, A gave B 10 yards the start and beat him by 2 yards. If B can run the distance in  $30\frac{1}{4}$  seconds, how long would it take A?

137. If a man earns \$3.36 a week; how much a year has he to live upon after paying \$0.45 a week for rent?

138. A gentleman had 6 sons among whom he divided \$3.25, so as to give the oldest \$0.25 more than each of the others; how many cents did he give to each?

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139. A tradesman made  $3\frac{1}{2}\%$  profit on goods sold for \$31.50; what was the cost of the goods?

140. A man rows 10 miles in  $2\frac{1}{4}$  hours against a stream which runs 3 miles an hour; how long will it take him to row 5 miles with the stream?

141. What profit per cent. does a market-woman make who buys ducks at 84 ct. each, and sells them at \$11.04 a dozen?

142. A merchant sold 12 yards of cloth for \$2.16, gaining thereby the cost of 2.4 yd.; what was his profit per cent., and what was the cost of the cloth per yard?

143. What is the present value of \$155.25 due in 1 yr. at  $3\frac{1}{2}$  per cent.?

144. What is the difference per cent. in selling 4 yd. of cloth for the price of 5 yd., and selling 5 yd. for the cost of 6 yd.?

145. In a race of 160 rods, A gives B 5 yd. start and beats him by 10 yd.; B gives C 15 yd. start, and is beaten by 30 yd.; which runs the faster A or C?

146. A man walking 35 miles observes when he has been 4 hours on the road, that he has walked  $\frac{3}{4}$  of the remaining distance; at what rate per hour was he walking?

147. A milkman buys milk at 5 cents a quart, and sells it at 6 cents a quart; how much water has he put with it if his profit is 25%?

148. A and B agree to do a piece of work for \$15. A could do it alone in 5 days, and B in 6 days; with the assistance of a boy they do it in 2 days; how should the money be divided?

149. If in a hundred yards, A can give B 10 yards the start, and B can give C 10 yd. the start, how many yards start can A give C?

150. If a merchant loses  $16\frac{2}{3}\%$  in selling a piece of cloth at 20 cents a yard, at what price per yard should he sell to gain  $12\frac{1}{2}\%$ ?

151. What is the rate per cent. of gain or loss when coal bought at \$3.75 a ton is sold at 25 ct. per cwt.?

152. The cost of 3 chickens and 5 turkeys was \$4.50. The cost of a chicken was  $\frac{1}{3}$  of the cost of a turkey; what was the cost of a chicken?

153. A does  $\frac{2}{3}$  of a piece of work in 4 hours; B does  $\frac{2}{3}$  of the remainder in 2 hours, and C finishes in 1 hour; how long would it have taken them working together?

154. A gentleman gave some boys 5 cents each; had he given them 7 cents each, it would have taken 16 cents more; how many boys were there?

155. A farmer hires a man at \$18 a month; if the man idles away 10% of his time, how much a month does the farmer really pay him?

156. What must a clothier ask for a suit of clothes costing \$20, in order that he may deduct 10% from the price asked, and still make  $12\frac{1}{2}\%$  on cost?

157. There was a loss of 4% of the contents of a cask of molasses by leakage; what per cent. profit must be charged on the remainder to cover the loss?

158. What is the bank discount upon \$20 for 75 days at 8%?

159. What is the net cost of a set of chairs listed at \$15 and sold at  $\frac{1}{4}$  and  $\frac{1}{8}$  off?

160. What are the present worth and true discount of \$60 due in 4 years at 5%?

161. What will \$30 amount to in 10 months at 7%?

162. In what time at 6% is the interest equal to  $\frac{1}{18}$  of the amount?

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163. At what rate per cent. will the amount in 3 years 4 months be  $1\frac{1}{2}$  times the principal?

164. A merchant bought goods at a discount of 25 and 20 from list price, and sold them at an advance of  $\frac{1}{4}$ ; what per cent. of the list price did he receive?

165. If a dealer buy goods at a discount of 20 and 10, how must he sell them to gain 25%?

166. What per cent. profit is made by buying goods at a discount of  $\frac{1}{4}$  and  $\frac{1}{10}$ , and selling at the list price?

167. What is the bank discount of \$60 for 75 days at 8%?

168. What are the present worth and true discount of \$60 for  $2\frac{1}{2}$  months at 8%?

169. A boy went to a store with a certain sum of money; he borrowed there one half as much more and spent 18 cents; he went then to another store where he borrowed one half as much money as he had and spent 18 cents, which was all the money he had; how much money had he at first?

170. A boy having a number of marbles lost  $\frac{1}{4}$  of them; he then bought  $\frac{1}{4}$  as many as remained and again lost  $\frac{1}{4}$  of his number, when he had 54 marbles remaining; how many marbles had he at first?

171. A farmer having sold a cow, divided  $\frac{3}{4}$  of what he got for her, equally, among his six children, and had  $\frac{1}{4}$  of \$24 remaining; what was the price of the cow, and what part of it did each of the children receive?

172. A farmer paid two hired men \$34 for a month's work; if  $\frac{2}{3}$  of A's share was  $\frac{2}{3}$  of B's, what was the monthly wages of each?

173. If \$35 be divided in two parts, one of which is \$5 more than  $\frac{2}{3}$  of the other, what is the ratio of one part to the other?

174. A man's age at time of marriage was  $1\frac{1}{2}$  times the age of his wife, but at the end of 6 years the age of the wife was the same as that of her husband at the time of their marriage; what was the age of each when they were married?

175. A man can do a piece of work in 6 days, working 8 hours each; in how many days can he do the same work, working 10 hours a day?

176. A hound starts to catch a rabbit which is 50 of its leaps ahead; the rabbit takes 4 leaps to the hound's 3, but 2 of the hound's leaps make 3 of the rabbit's; how many leaps must the hound take to catch the rabbit?

177. Two boys, James and Henry, are 220 rods apart and start to meet each other; how far will each walk, if James takes 4 steps while Henry takes 6, and 4 of James's steps equal 5 of Henry's?

178. Mary is 10 years old and Susan is 15 years old; in how many years will Mary be  $\frac{4}{5}$  as old as Susan?

179. A and B do a piece of work together for \$30; the number of days A works is 3 more than  $\frac{1}{2}$  of the number that B works, and A receives \$20; how many days did each work?

180. What number is it which, being multiplied by 5, becomes as much more than 60 as it now is less?

181. A boy went to a store, borrowed 10 cents and spent 12 cents; he did this at a second and at a third store, and then had no money left; how much money had he at first?

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182. What number is it which, being subtracted from 40, the remainder is  $\frac{1}{5}$  of the sum of the number and 40?

183. B had \$36 and A had  $\frac{5}{6}$  as much as B. They gained equal amounts by which A came to have  $\frac{2}{3}$  as much money as B; how much was gained?

184. A had \$32 and B, \$40; A paid B a certain sum by which A came to have  $\frac{1}{2}$  as much money as B; how many dollars did A pay?

185. A man bought a number of barrels of flour; he sold 20% of them to one man and  $16\frac{2}{3}\%$  of the remainder to another, and had 20 barrels left; how many barrels did he buy?

186. Sold some hay for \$14, gaining  $\frac{1}{4}$  of the cost; what would have been the loss per cent. by selling for \$9?

187. An agent receives \$234 to expend in goods, retaining 4% on the money expended; required the amount expended and the commission.

188. An agent sold a city lot for \$250 on a commission of 4%, and expended the net proceeds of the sale in flour at \$8 a barrel; how many barrels did he buy?

189. How many yards of cloth must be bought at \$3 a yard, so that by selling it at a profit of 25% there may be a gain of \$15?

190. A cattle dealer sent his agent \$530 with which to purchase sheep and cows, expending 4 times as many dollars for cows as for sheep; what sum will the agent expend for each, after deducting his commission of 6% of the money expended?

191. A had  $\frac{3}{4}$  as much money as B, and the sum of the interest received by the two for 2 years at 6% was \$60; how much money had each?

192. At what rate per cent. will the interest of \$25 be \$3.50 in 2 years?

193. A and B engage in a speculation, A putting in \$50 and B \$75; at settlement a gain of 25% on the investment was found to have been made; how should the gain be divided?

194. A town lot is 112 ft. long and 70 ft. wide; it is desired to fence it in such a manner that the panels shall be of equal length; what is the length of the longest boards that may be used?



195. In a mixture of wine and cider  $\frac{1}{2}$  of the whole plus 25 gal. was wine and  $\frac{1}{3}$  of the whole less 5 gal. was cider; how many gallons were there of each?

196. A, B, and C start from the same point and travel in the same direction round an island 20 miles in circumference. A goes 3 miles an hour, B 7 miles, and C 11 miles; in how many hours will they be together?

197. A horse and carriage cost \$196, and the carriage cost 75% of the cost of the horse; what was the cost of each?

198. A man sold a horse at a loss of 10%; how much more would he have received for the horse had he sold it at a gain of  $12\frac{1}{2}\%$ ?

199. To realize a profit of 20%, what price per pound must a grocer charge for a mixture of three kinds of sugar costing 4, 5, and 6 cents a pound, there being 6 lb. of the first kind to 4 lb. of the second, and 2 lb. of the third?

200. In a false balance of which one arm is  $1\frac{1}{8}$  as long as the other, a pound weight on the long arm will balance  $1\frac{1}{8}$  lb. on the short arm; and a pound weight on the short arm will balance  $\frac{8}{9}$  lb. on the long arm. How might such a balance be used so as to cheat both in buying and selling? What would the error, in that way, amount to on 24 lb. of butter?





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